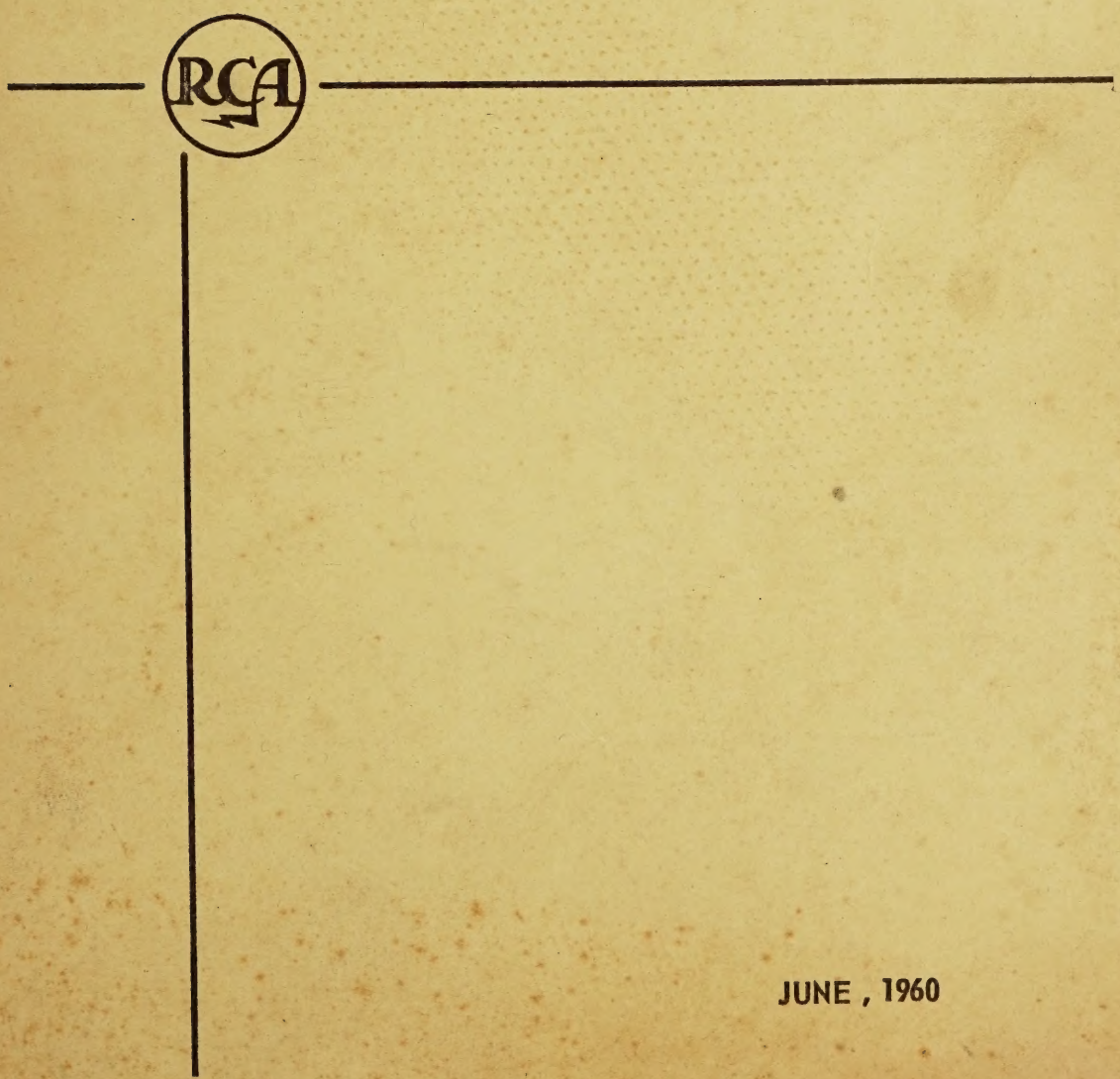
PRELIMINARY TECHNICAL TRAINING MANUAL

for the

RCA TELEVISION TAPE RECORDER



JUNE , 1960

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A BRIEF INTRODUCTION TO THE RCA TELEVISION TAPE RECORDER

A television tape recorder is not a single piece of apparatus, but a relatively complex *system* combining many electronic and mechanical devices to achieve a common objective – the recording of television programs (both picture and sound) on magnetic tape. Such a system can be most readily understood as an assemblage of *sub-systems*, each of which accomplishes a relatively simple, well-defined objective as a step toward the main objective. In the case of the RCA TRT-1AC Color Television Tape Recorder, it is reasonable to describe the system in terms of the nine sub-systems summarized in the following list. The monochrome version of the machine (Type TRT-1A) requires only the first eight of the nine sub-systems.

1. The *Tape Transport* is a large panel containing mechanical and electro-mechanical components for transporting magnetic tape from a supply reel to a take-up reel and performing the basic operations of erasing, recording, and playing back the several tracks on which information is stored on the tape (See Figure 1-1). It is logically the "heart" of the machine, since the other sub-systems serve only to support one or more of the functions performed on the tape transport panel.

2. The *Timing Circuits* include two specific chassis (the Tone Wheel Amplifier and the Reference Generator) which generate or process several types of pulse signals to synchronize the operations of the inter-related circuits and motors in the machine. The timing circuits are roughly analogous to the sync generators used in conventional television studio systems.

3. The *Head-Wheel Servo System* controls the speed and phase of the motor which drives the video recording heads in a form of scanning motion across the 2-inch-wide magnetic tape. Each revolution of the head-wheel motor records or plays back four transverse video tracks, since four heads are mounted around the periphery of the head wheel. While recording, the motion of the head-wheel motor is locked to the synchronizing information in the recorded signal, so that every TV field occupies exactly 16 tracks on the tape. In playback, the head-wheel motion is locked either to a local synchronizing signal or to the 60-cycle power line to establish a reliable timing reference.

4. The *Capstan Servo System* controls the speed with which tape is pulled through the machine by the rotating capstan and pinch roller. The linear tape speed is nominally 15 inches per second, but during playback it is necessary to control the capstan speed rather precisely to assure that exactly four video tracts are pulled past the rotating head-wheel assembly for each revolution of the head wheel. Facilities for recording and playing back a control track are included in the capstan servo system. The control track contains an accurate record of the relative speed of the head-wheel motor at the time the recording was made, and is somewhat analogous to the sprocket holes in motion-picture film.

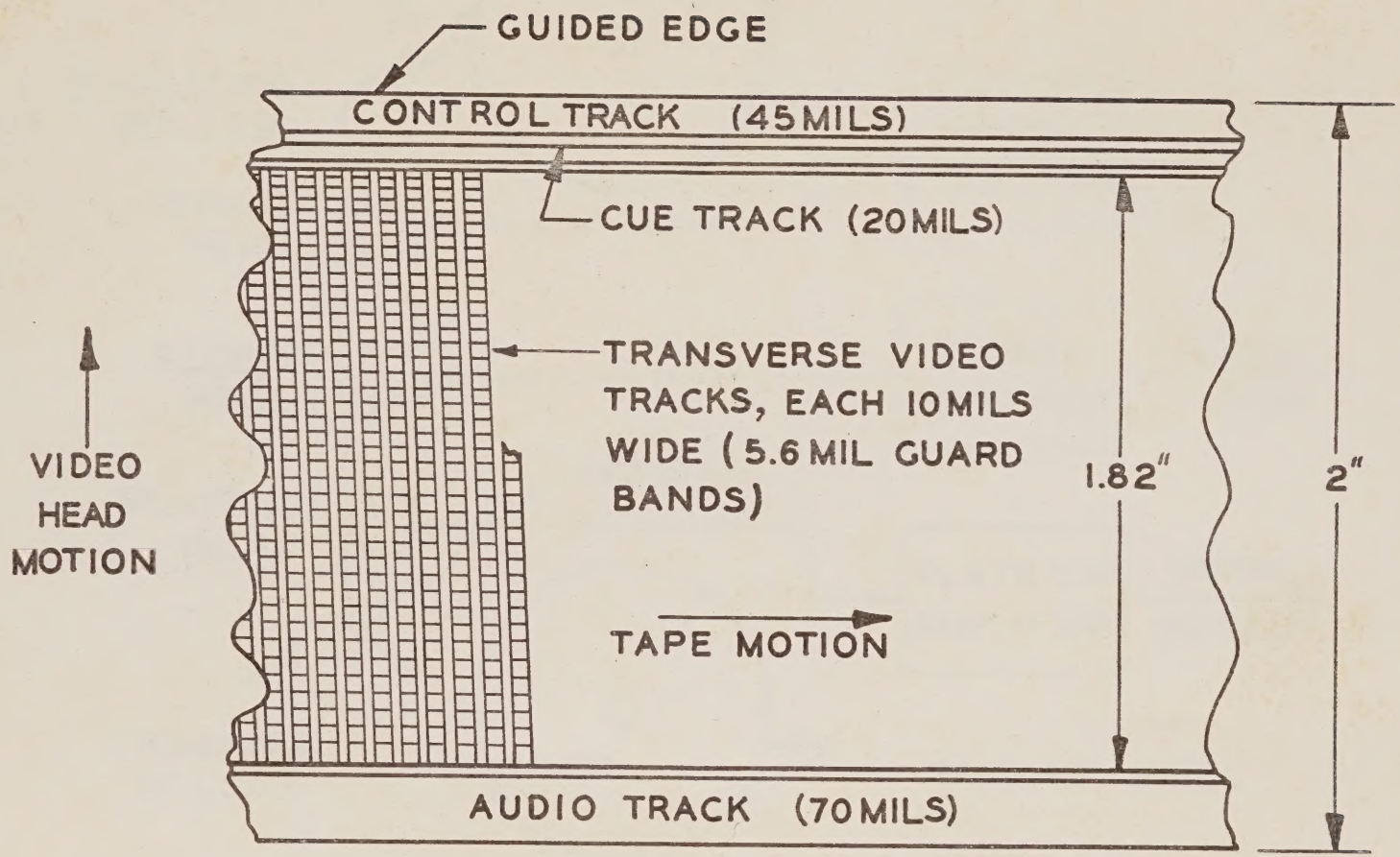
5. The *Shoe Servo System* controls the precise operating position of the guide shoe which "cups" the magnetic tape to conform to the circumference of the video head wheel. The shoe is designed to hold the tape so tightly against the rotating head wheel that the tape is actually stretched slightly as the heads pass over it. The precise shoe position determines the degree of this stretching action, which in turn determines the linear distance across the tape traversed by each head for a given amount of angular rotation. The shoe servo system automatically adjusts the position of the shoe during playback to compensate for the minor dimensional variations resulting from wear of the video heads, skrinkage or expansion of the tape medium, or variations in the degree of tape stretch during the original recording. The shoe servo thus prevents timing errors which could, if uncorrected, cause "jogs" or a "venetian blind effect" in reproduced pictures.

6. The *Audio and Cue Facilities* include Amplifiers, oscillators, and related facilities for erasing, recording, and playing back two audio tracks on the tape – one for program sound, and the other for cueing, identification, or special test information.

7. The *Video Record and Playback Facilities* include the amplifiers, equalizers, modulator, demodulator, and special processing circuits used to record and play back the television picture signal. The signal is applied to the tape in the form of a frequency-modulated wave to overcome certain basic limitations in the tape recording medium. In the "record" mode of operation, the incoming signal, after FM modulation, is split into four channels to drive the four recording heads around the video head wheel. In playback, switching circuits are employed to combine the four head channels into one before the signal is demodulated.

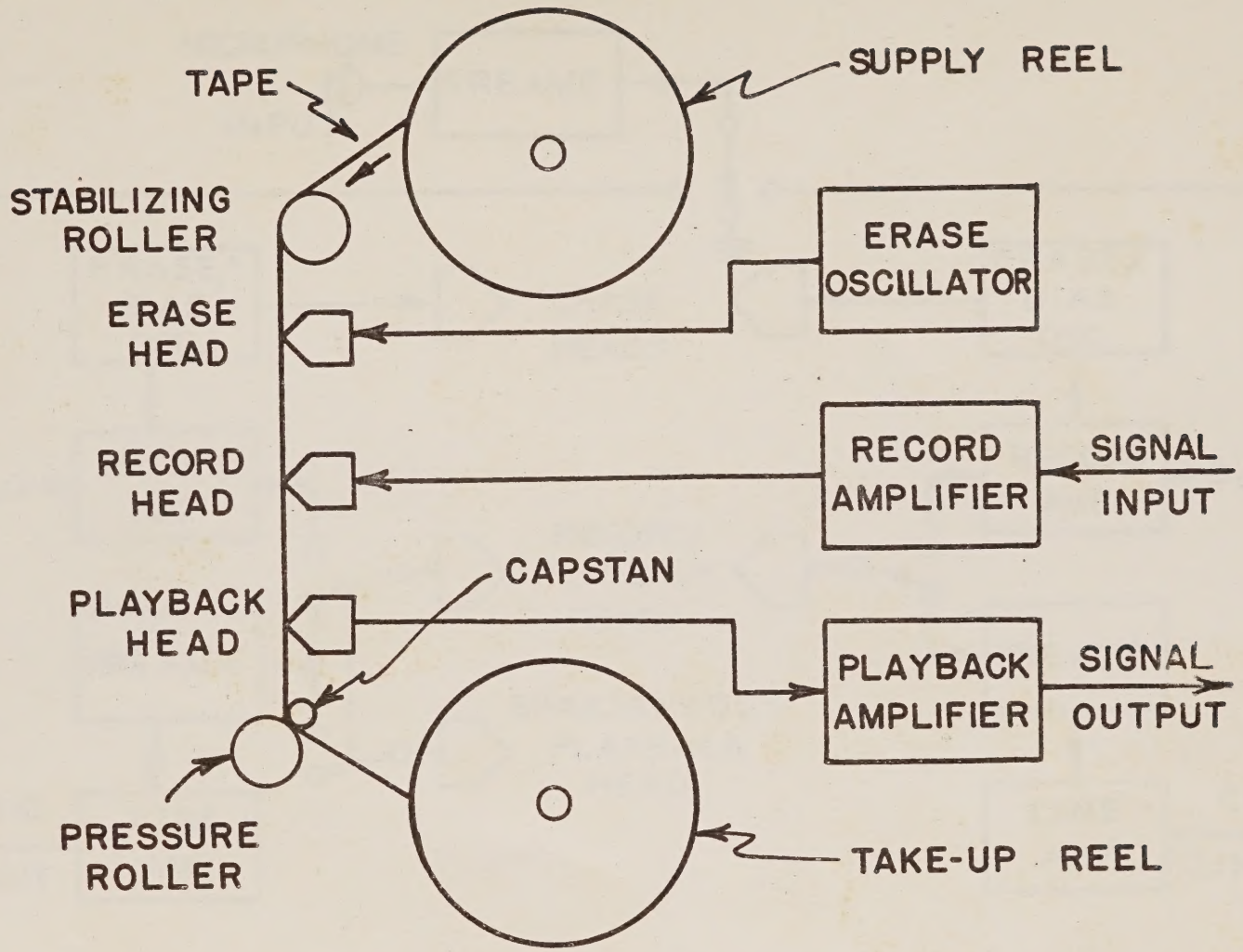
8. The *Monitoring and Control Facilities* include a picture monitor, a waveform monitor, and a centralized control panel for the entire machine. The electrical circuits from these components branch out to all the other sub-systems, since the objective of the monitoring and control facilities is to coordinate the activities of the entire machine.

9. The *Color Stabilization Equipment* consists of several chassis for processing the subcarrier portion of color television signals to remove the small timing variations remaining as a result of state-of-the-art imperfections in the servo systems. If uncorrected, these timing variations would cause "color banding" effects in color pictures. The color stabilization equipment is mounted in a separate rack, and is simply connected in series with the output of the rest of the machine when color performance is required.

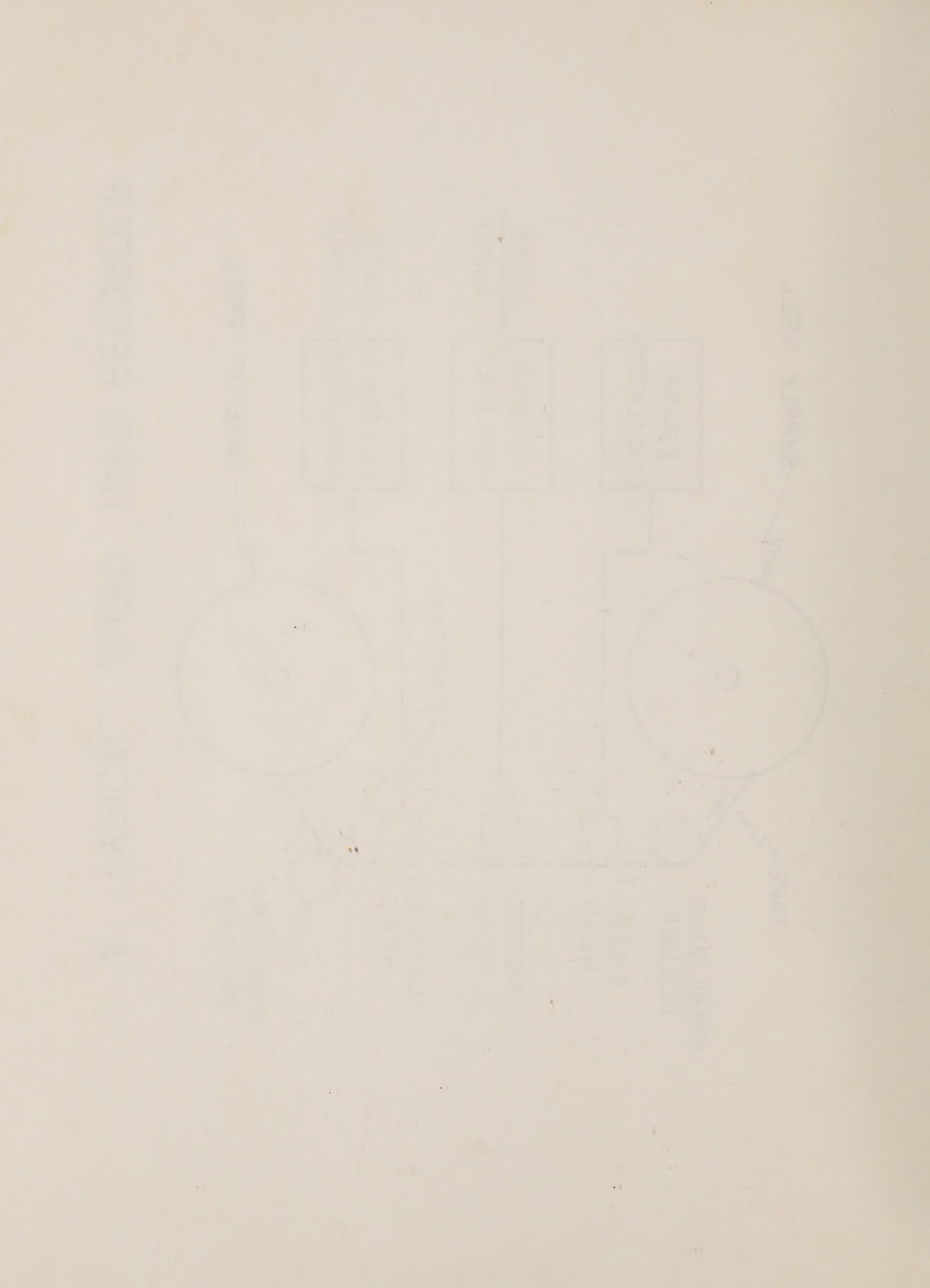


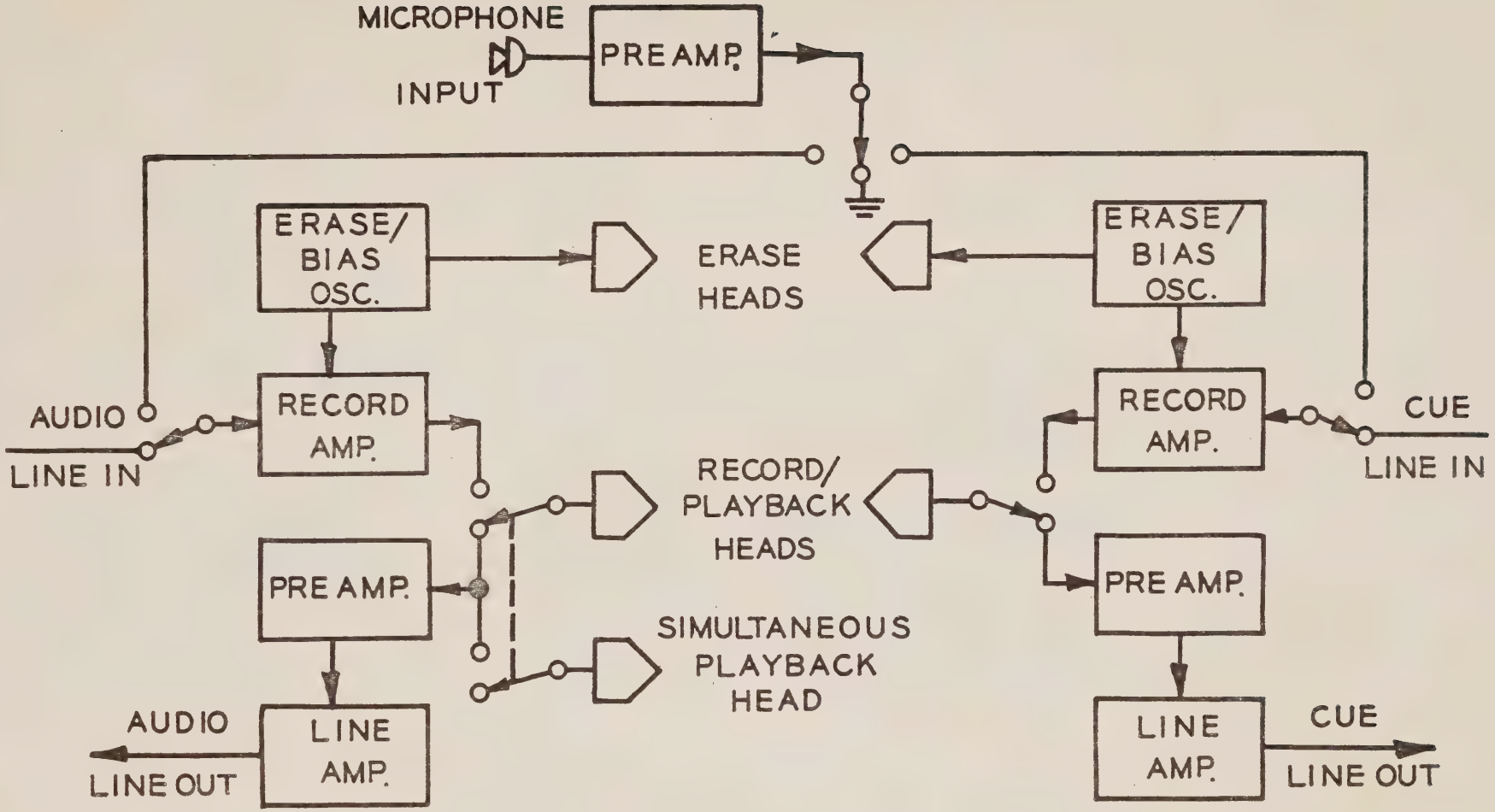
TRACKS ON TELEVISION TAPE

(NOT TO SCALE)

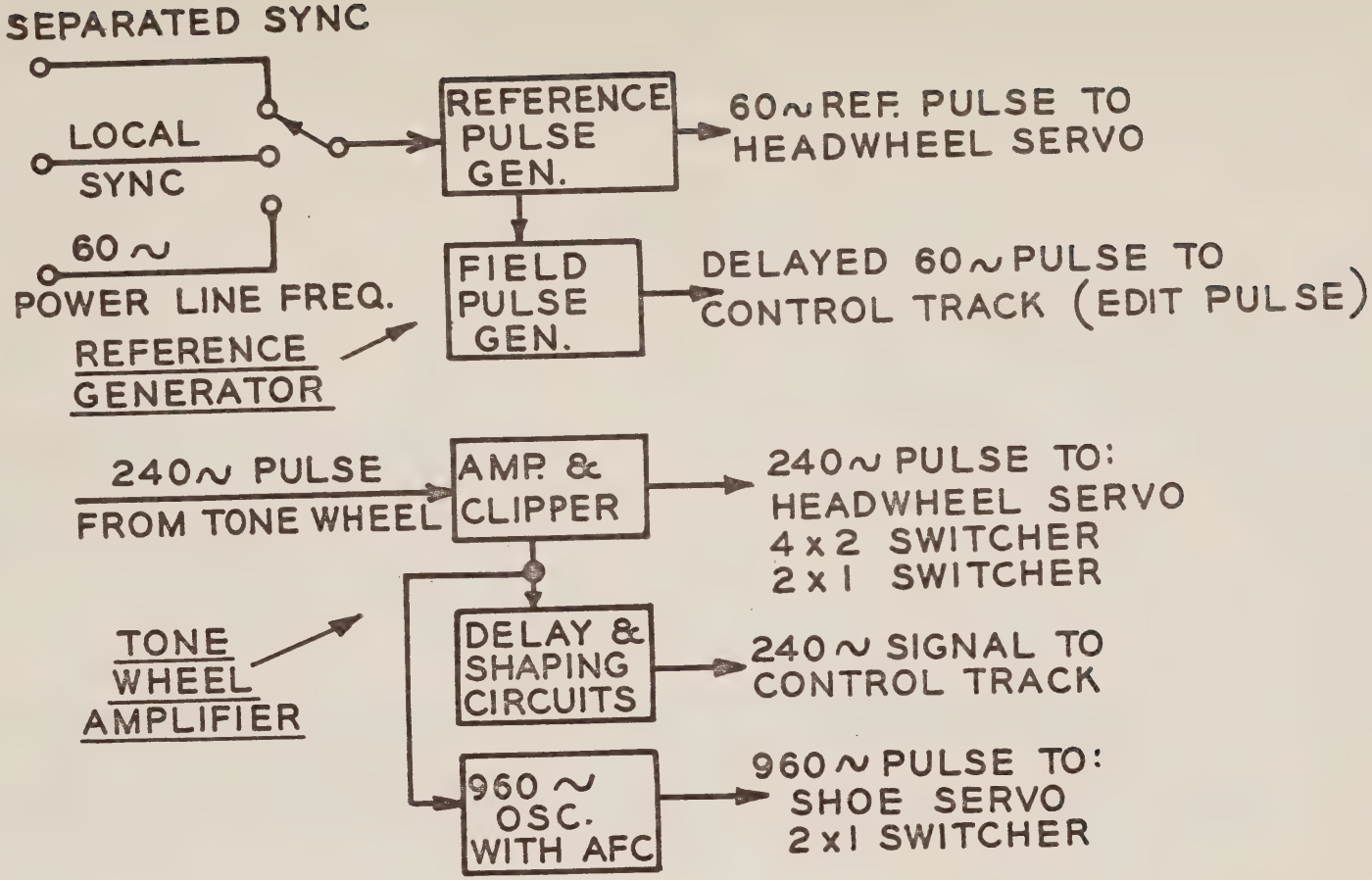


A TYPICAL AUDIO TAPE RECORDER

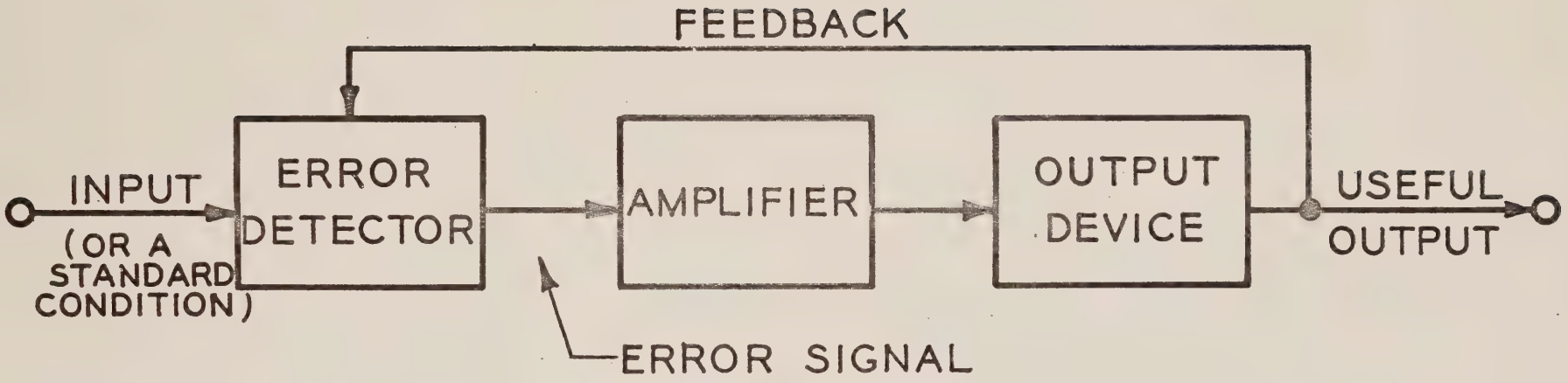




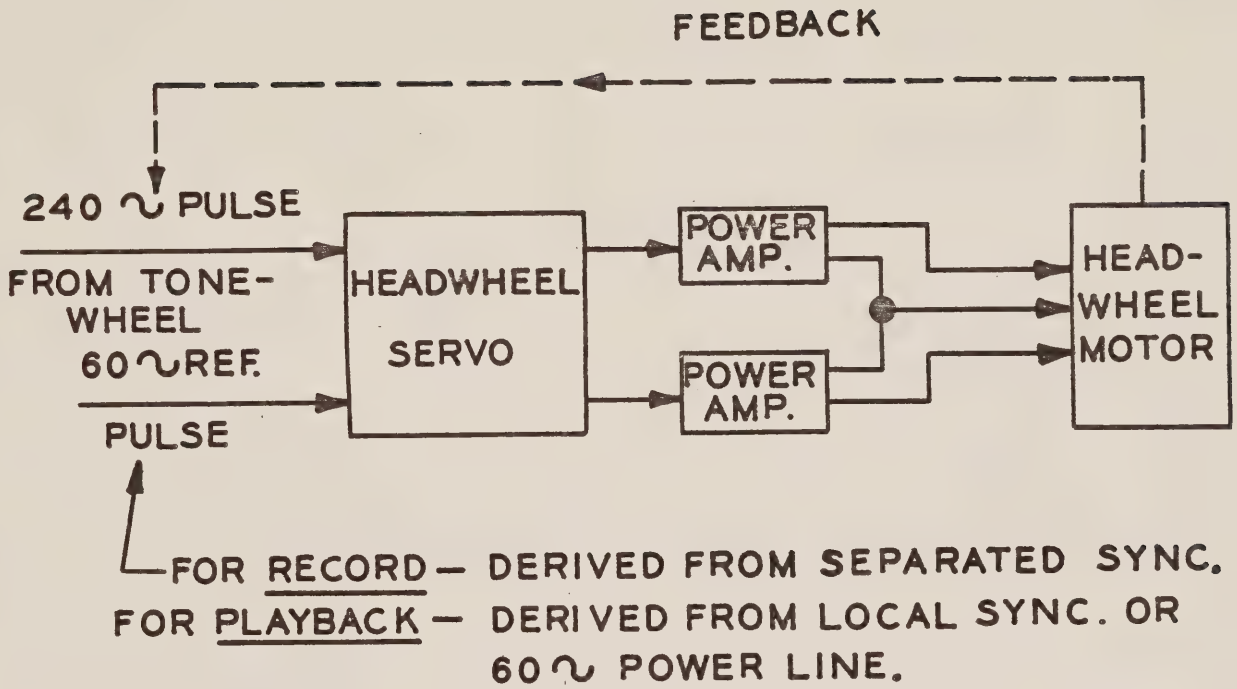
SIMPLIFIED DIAGRAM OF AUDIO AND CUE FACILITIES IN THE TRT-1A/1AC


SEPARATED SYNC
LOCAL SYNC
60 ~ POWER LINE FREQ.
REFERENCE GENERATOR
REFERENCE PULSE GEN.
60 ~ REF. PULSE TO HEADWHEEL SERVO
FIELD PULSE GEN.
DELAYED 60 ~ PULSE TO CONTROL TRACK (EDIT PULSE)
240 ~ PULSE FROM TONE WHEEL
AMP. & CLIPPER
240 ~ PULSE TO:
HEADWHEEL SERVO
4 x 2 SWITCHER
2 x 1 SWITCHER
TONE WHEEL AMPLIFIER
DELAY & SHAPING CIRCUITS
240 ~ SIGNAL TO CONTROL TRACK
960 ~ OSC. WITH AFC
960 ~ PULSE TO:
SHOE SERVO
2 x 1 SWITCHER

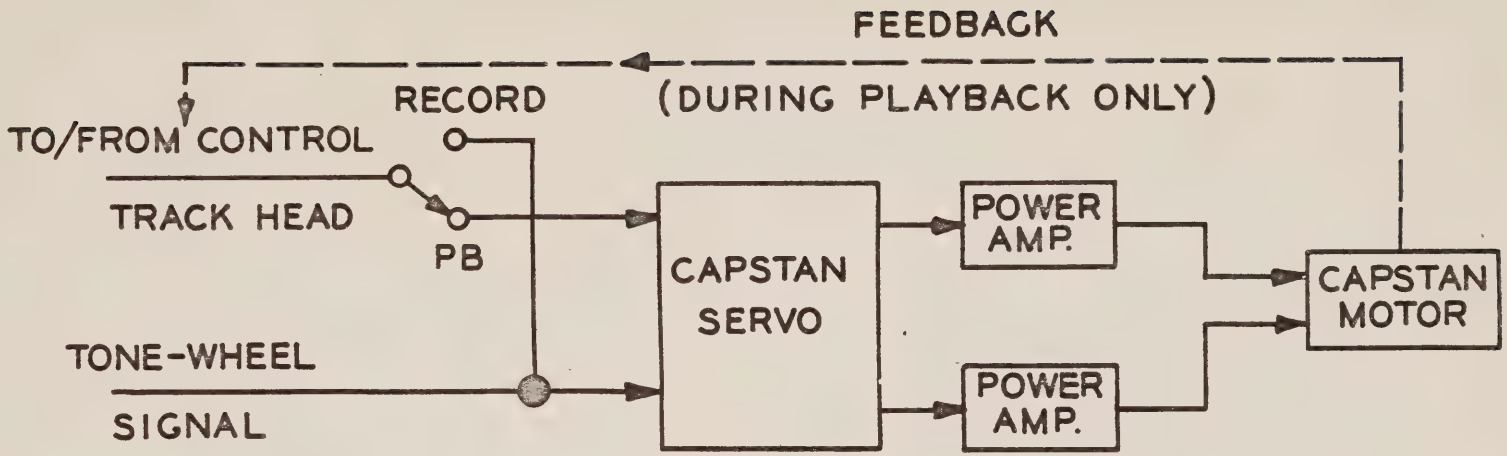
TIMING CIRCUITS FOR RCA TV TAPE RECORDER



GENERALIZED BLOCK DIAGRAM
FOR A CLOSED-LOOP SERVO SYSTEM



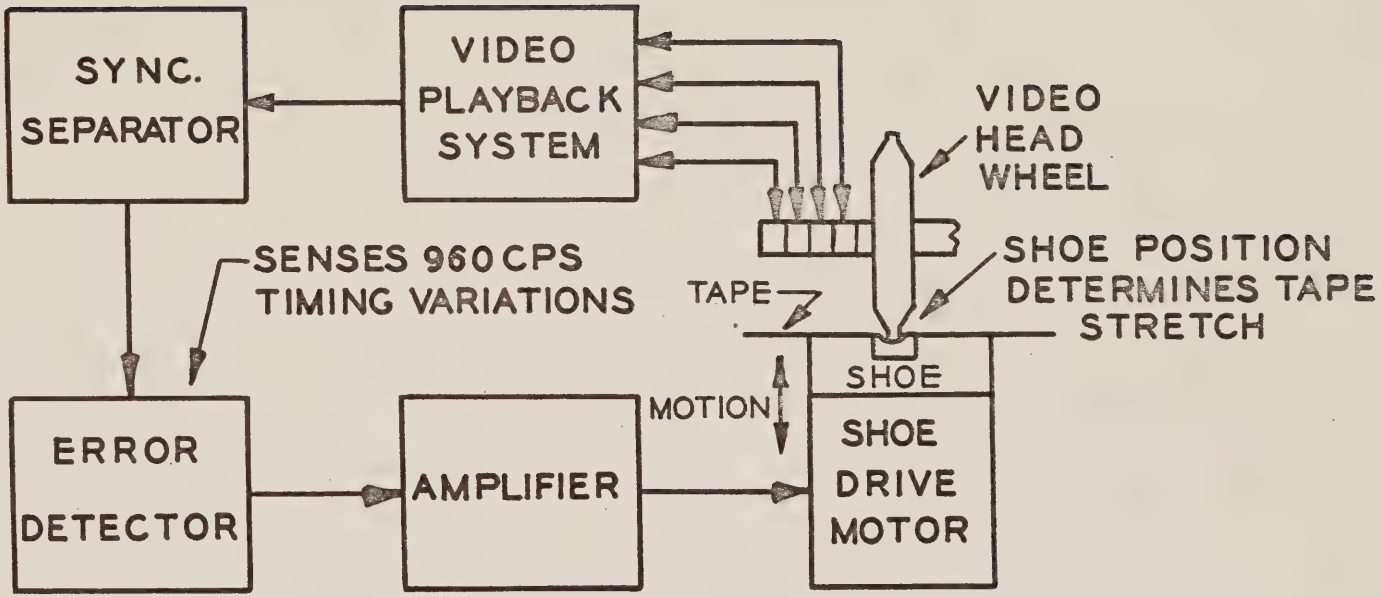
HEAD–WHEEL SERVO SYSTEM



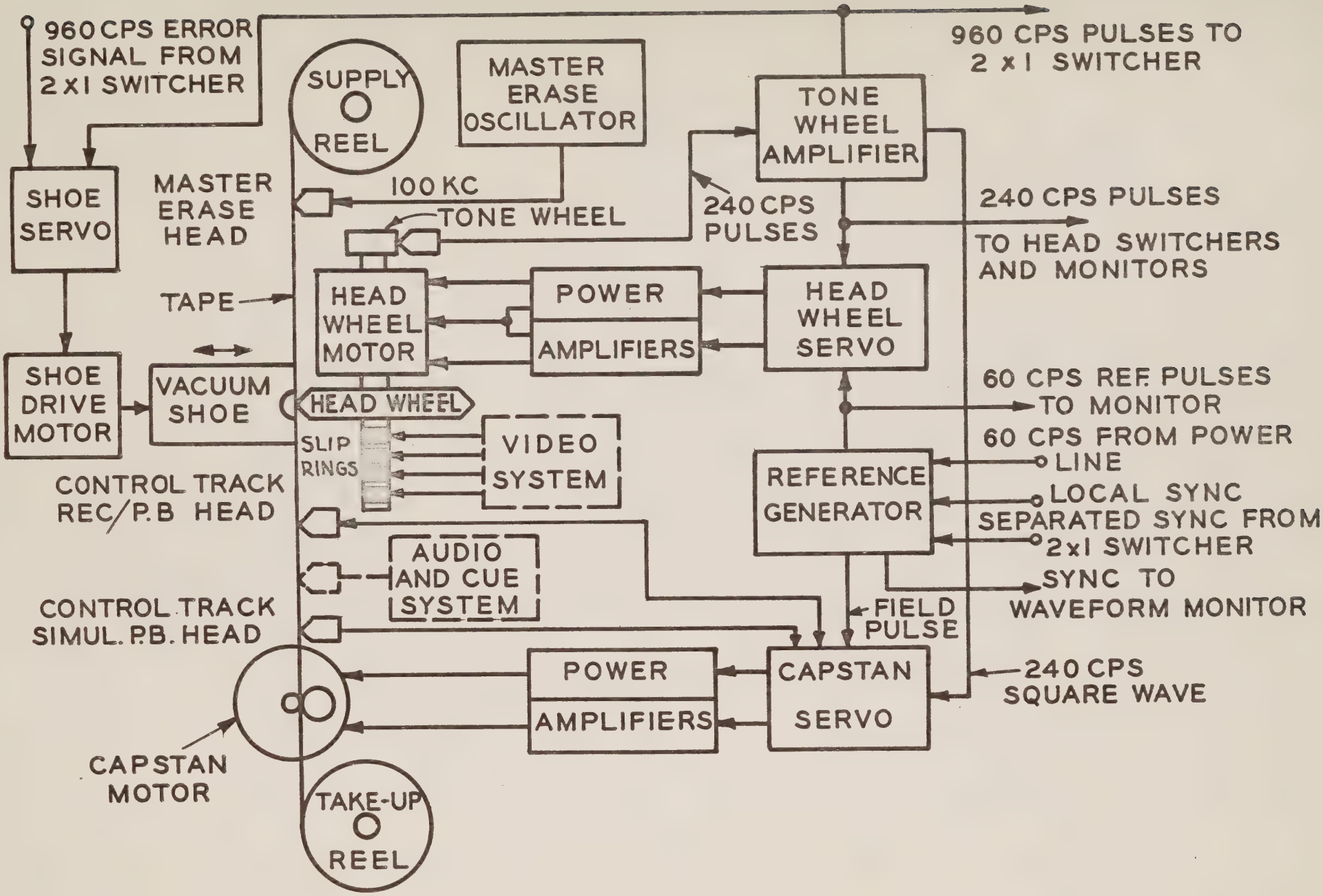
CAPSTAN SERVO SYSTEM

FOR RECORD— CAPSTAN MOTOR DRIVEN SYNCHRONOUSLY BY SIGNAL DERIVED FROM TONE-WHEEL. TONE-WHEEL SIGNAL ALSO RECORDED ON CONTROL TRACK.

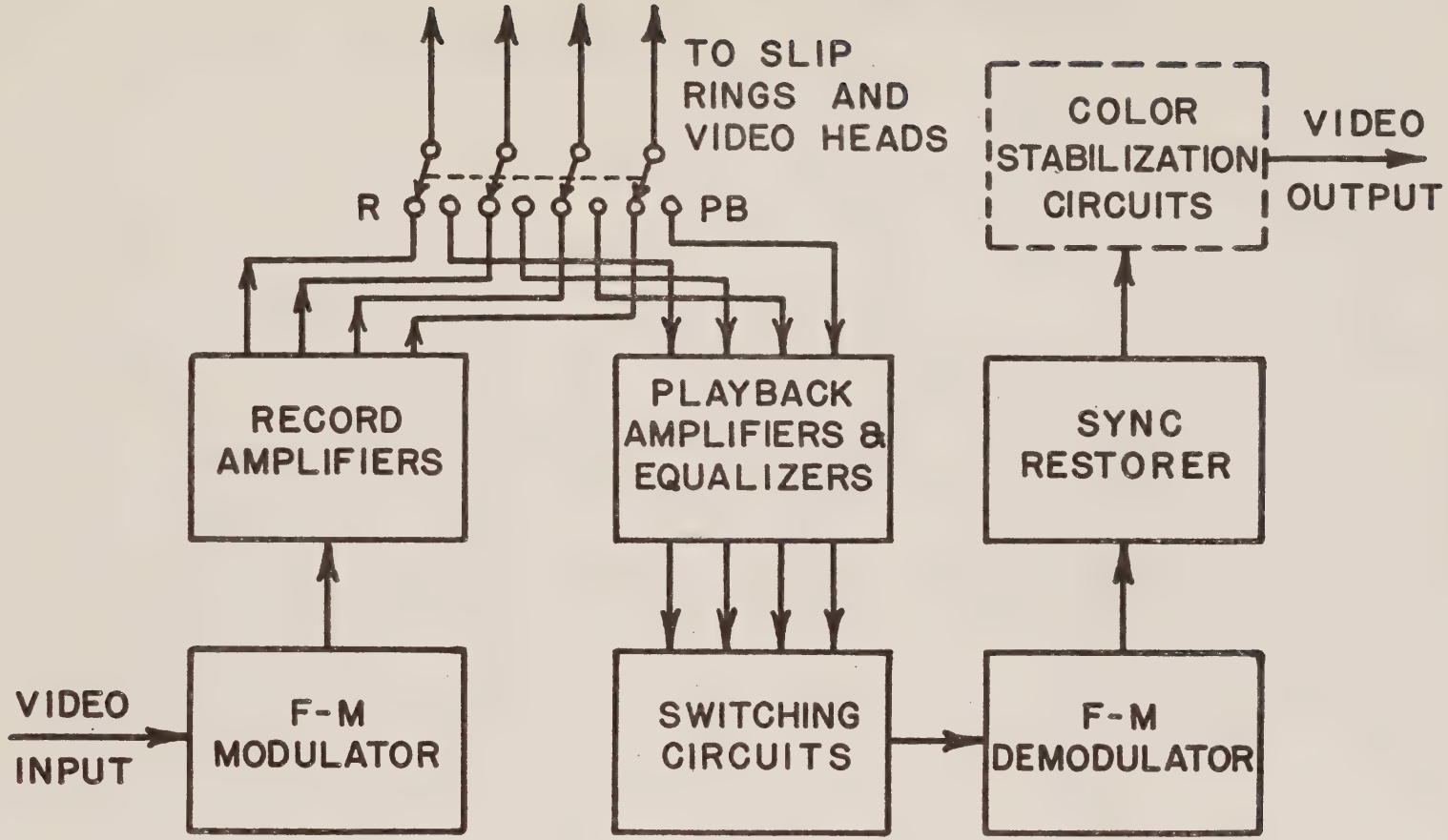
FOR PLAYBACK— SERVO SYSTEM MAKES CONTROL TRACK SIGNAL MATCH TONE-WHEEL SIGNAL.



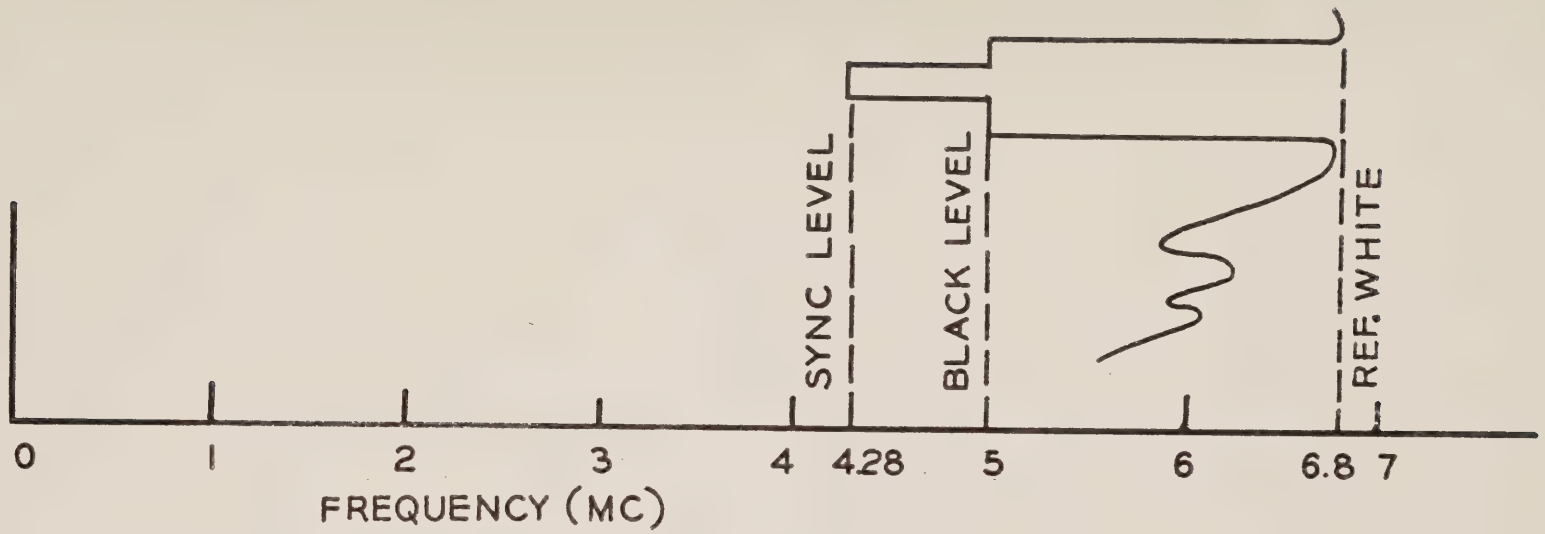
SIMPLIFIED BLOCK DIAGRAM OF
SHOE SERVO SYSTEM



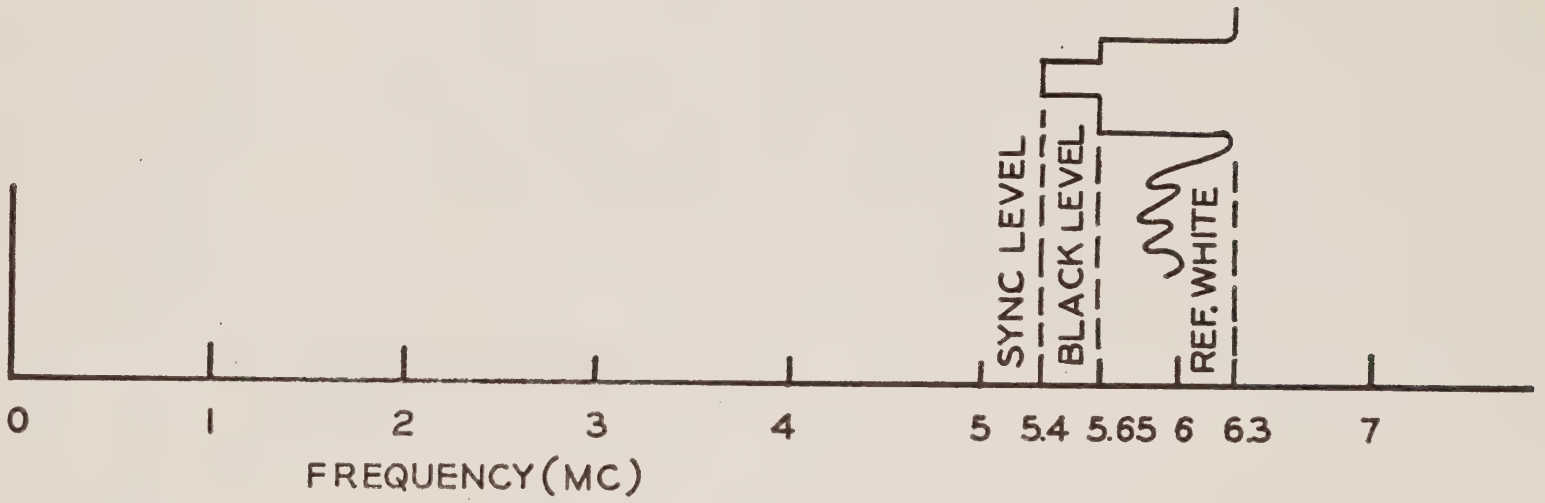
I-11 FUNCTIONAL DIAGRAM OF TRT-IA SERVO SYSTEMS



SIMPLIFIED BLOCK DIAGRAM OF
RCA TRT-1A/1AC VIDEO CIRCUITS

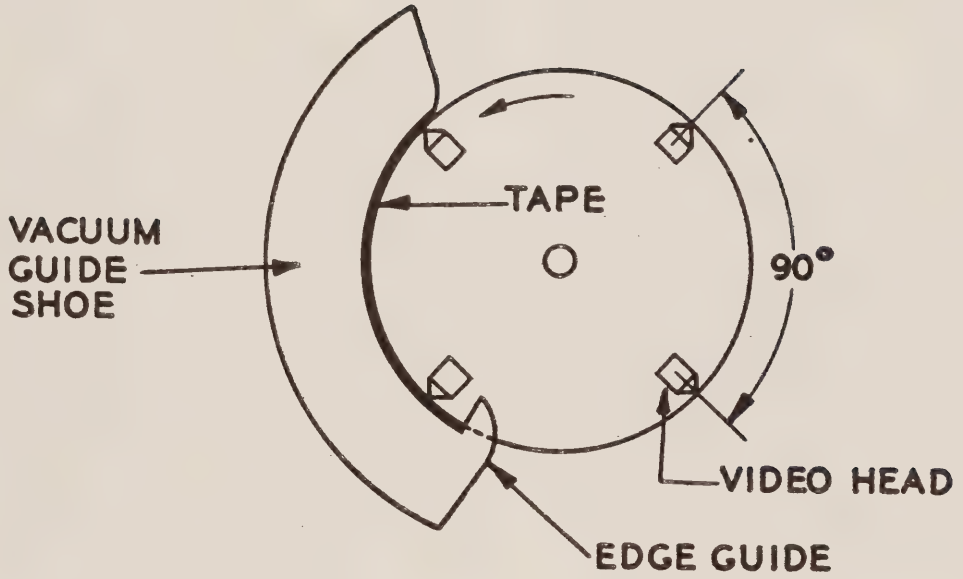


MONOCHROME

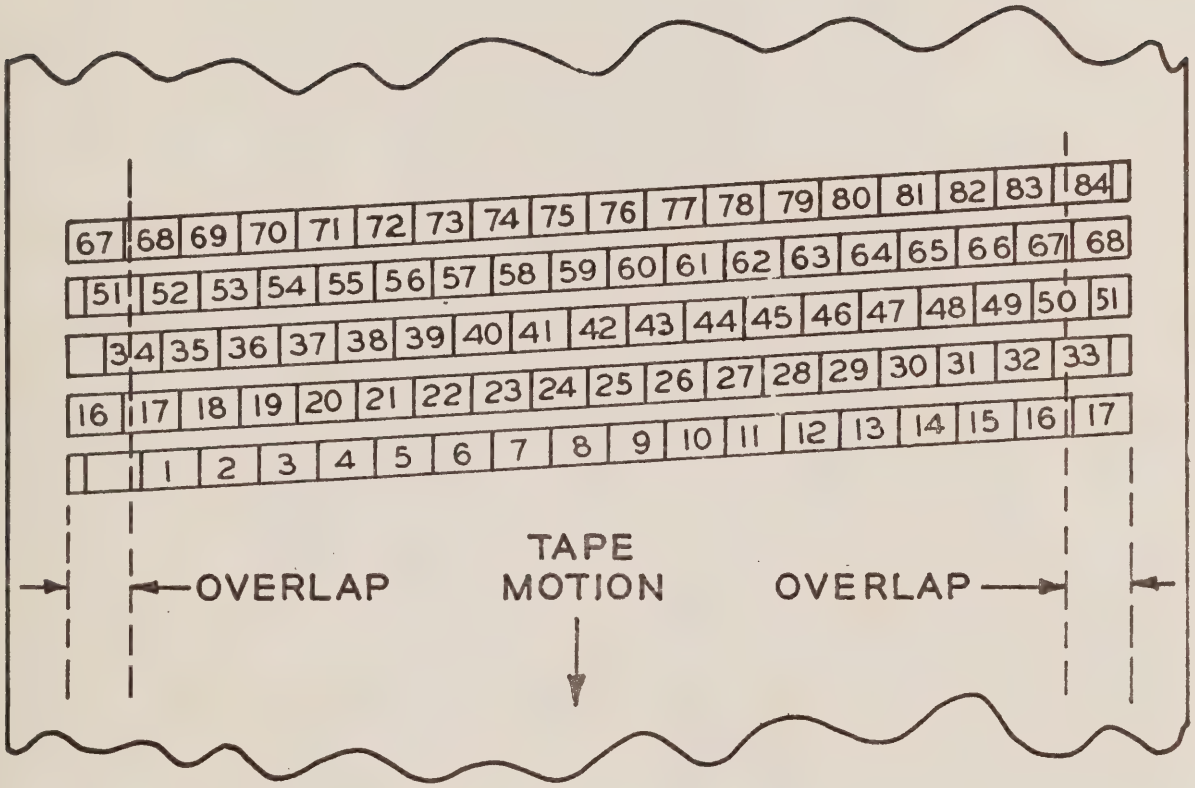


COLOR

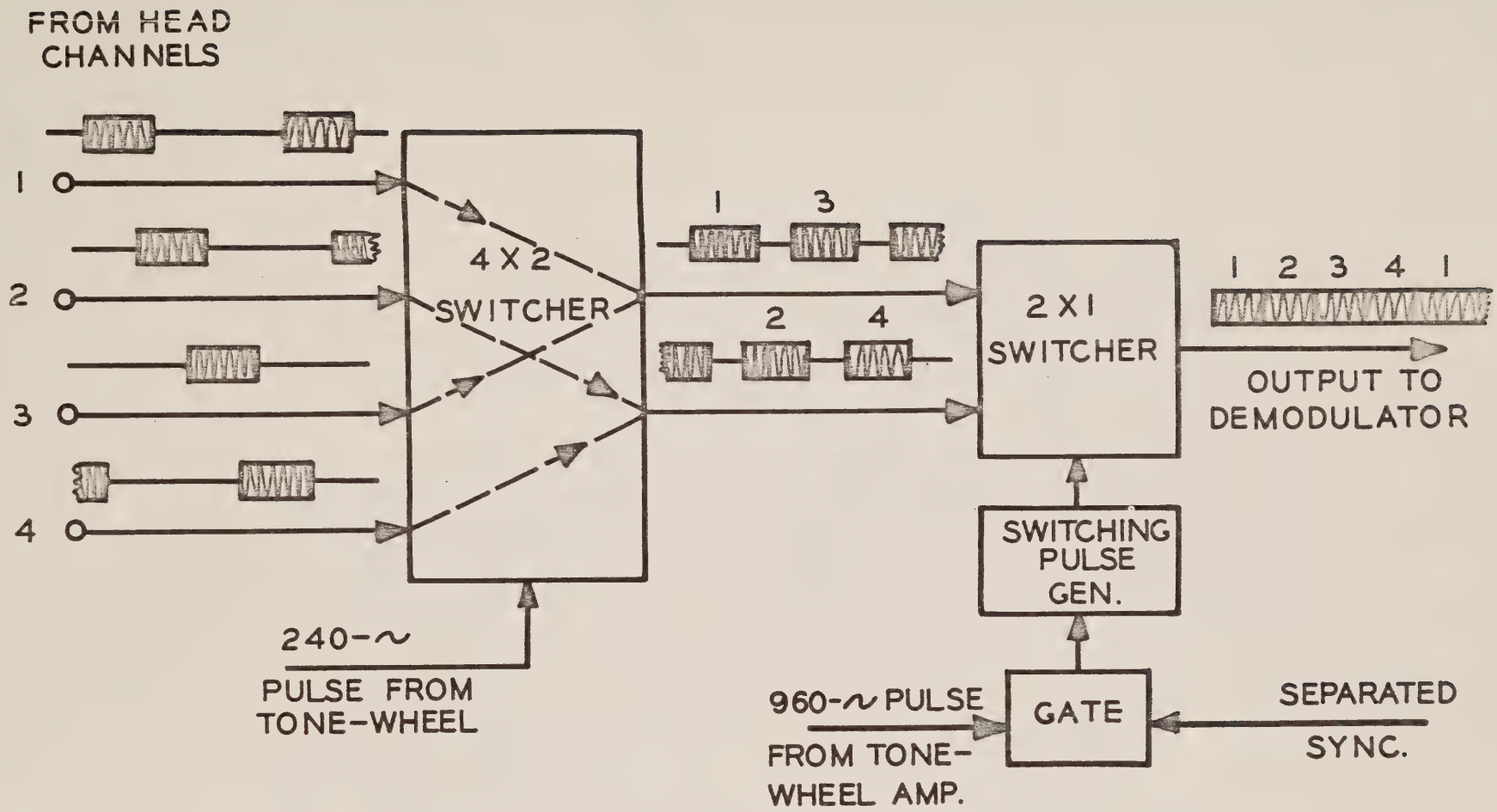
DEVIATION STANDARDS FOR TV TAPE RECORDING



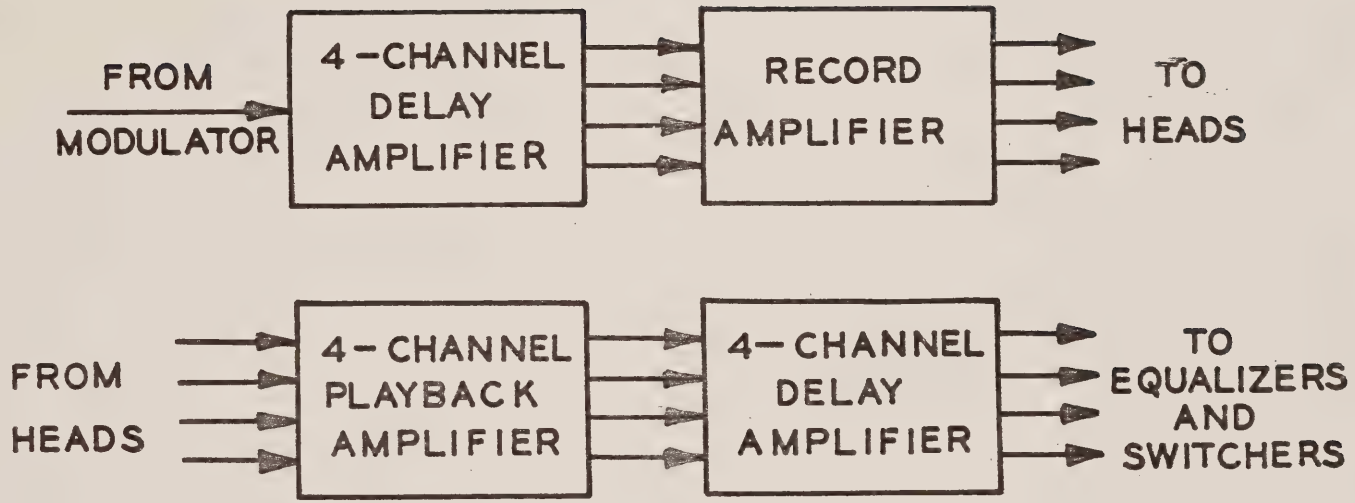
VIDEO HEAD WHEEL



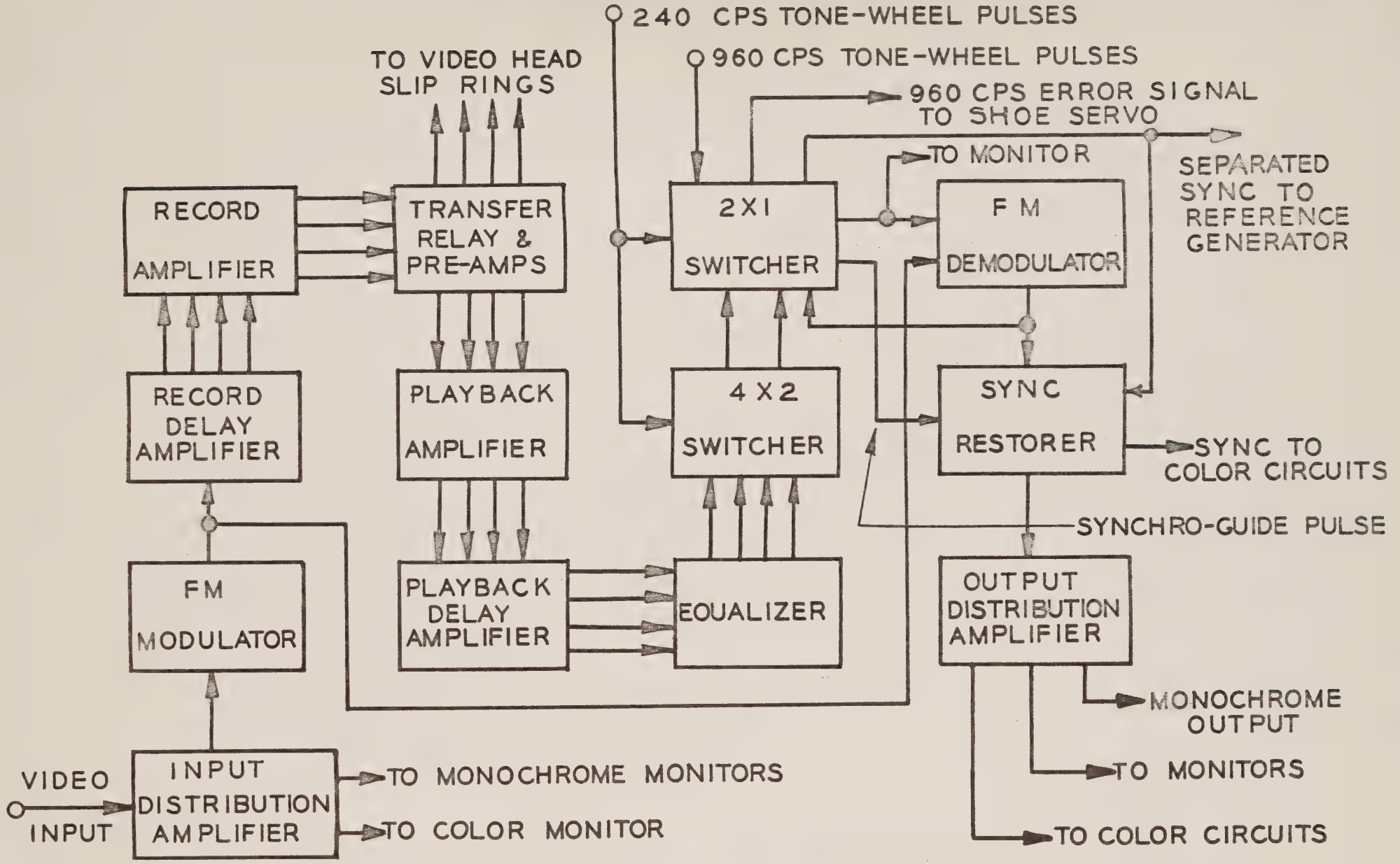
SKETCH SHOWING SEQUENCE OF TV LINES ON A SMALL SECTION OF TV TAPE (TRACK WIDTH GREATLY EXAGGERATED)



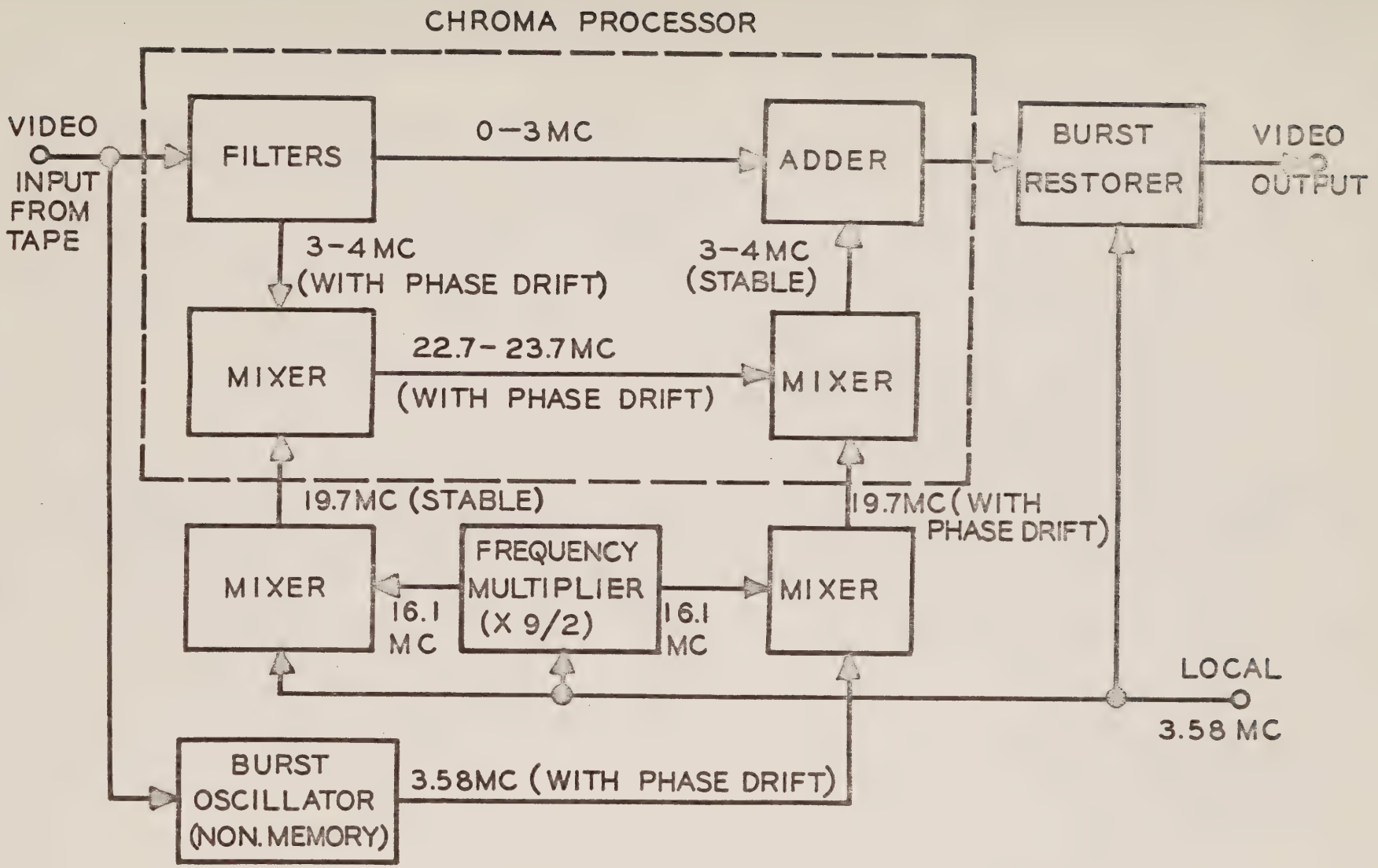
VIDEO SWITCHING CIRCUITS



BLOCK DIAGRAM SHOWING LOCATION OF ADJUSTABLE DELAY AMPLIFIERS FOR ELECTRONIC QUADRATURE ADJUSTMENT

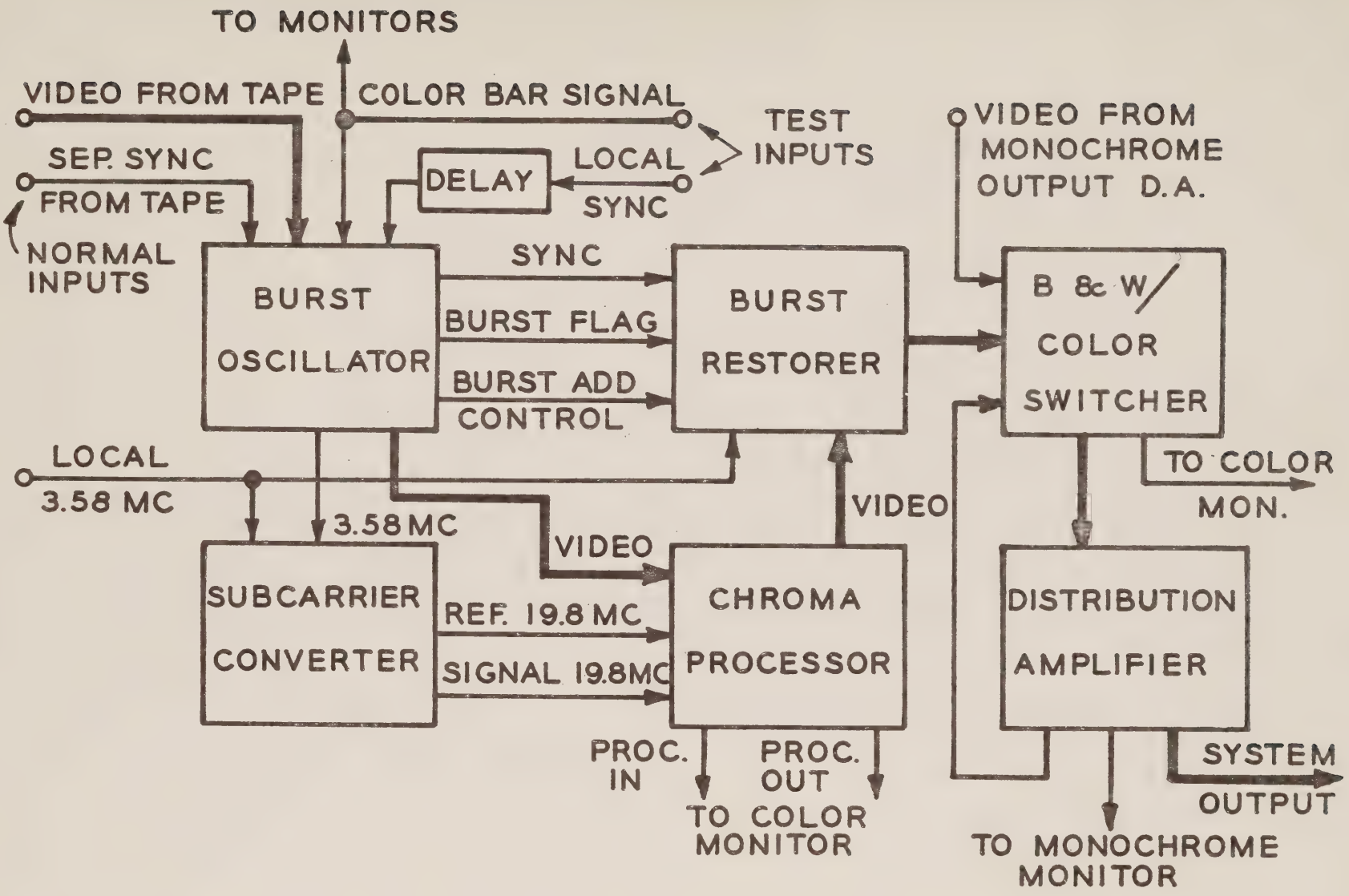


FUNCTIONAL DIAGRAM OF TRT-1A VIDEO SYSTEM

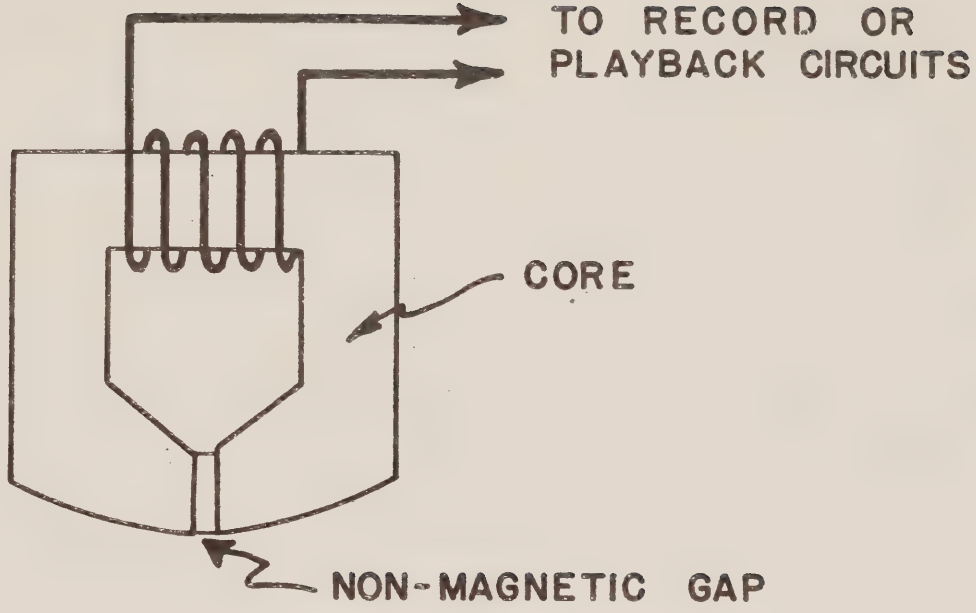


1-20

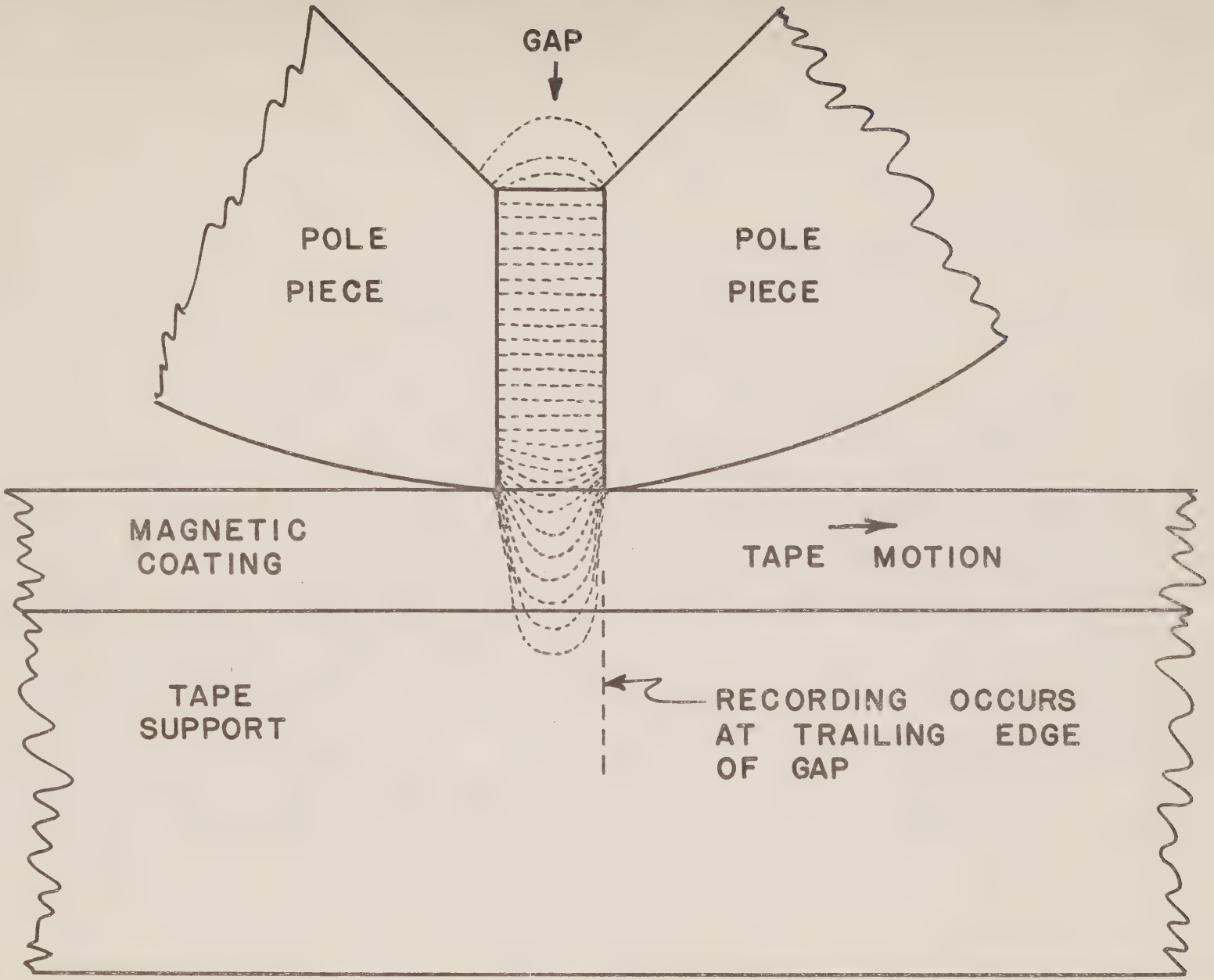
SIMPLIFIED BLOCK DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE TRT-IAC COLOR CORRECTION EQUIPMENT



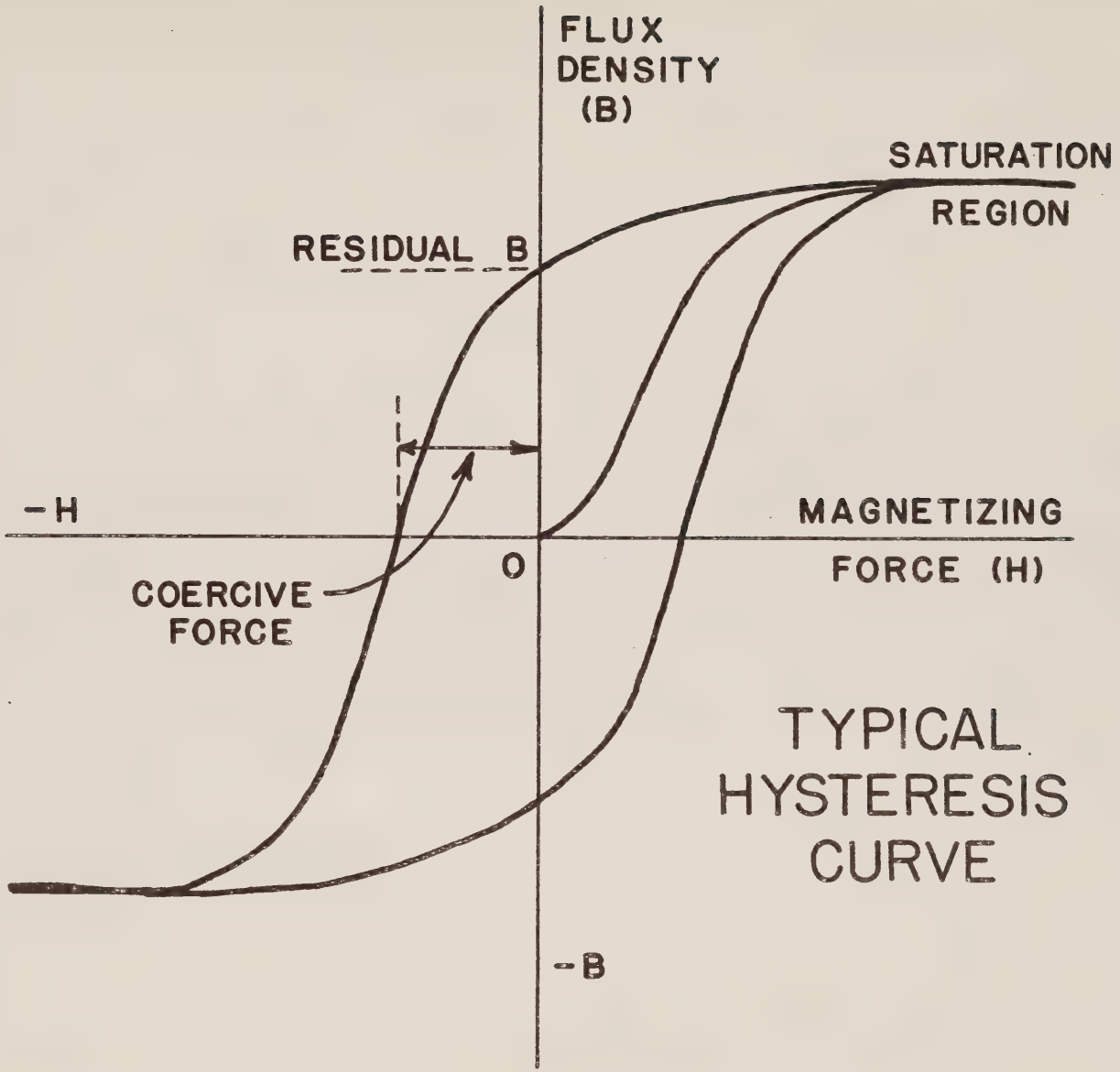
COLOR CORRECTION EQUIPMENT FOR THE RCA TRT-IAC TV TAPE RECORDER



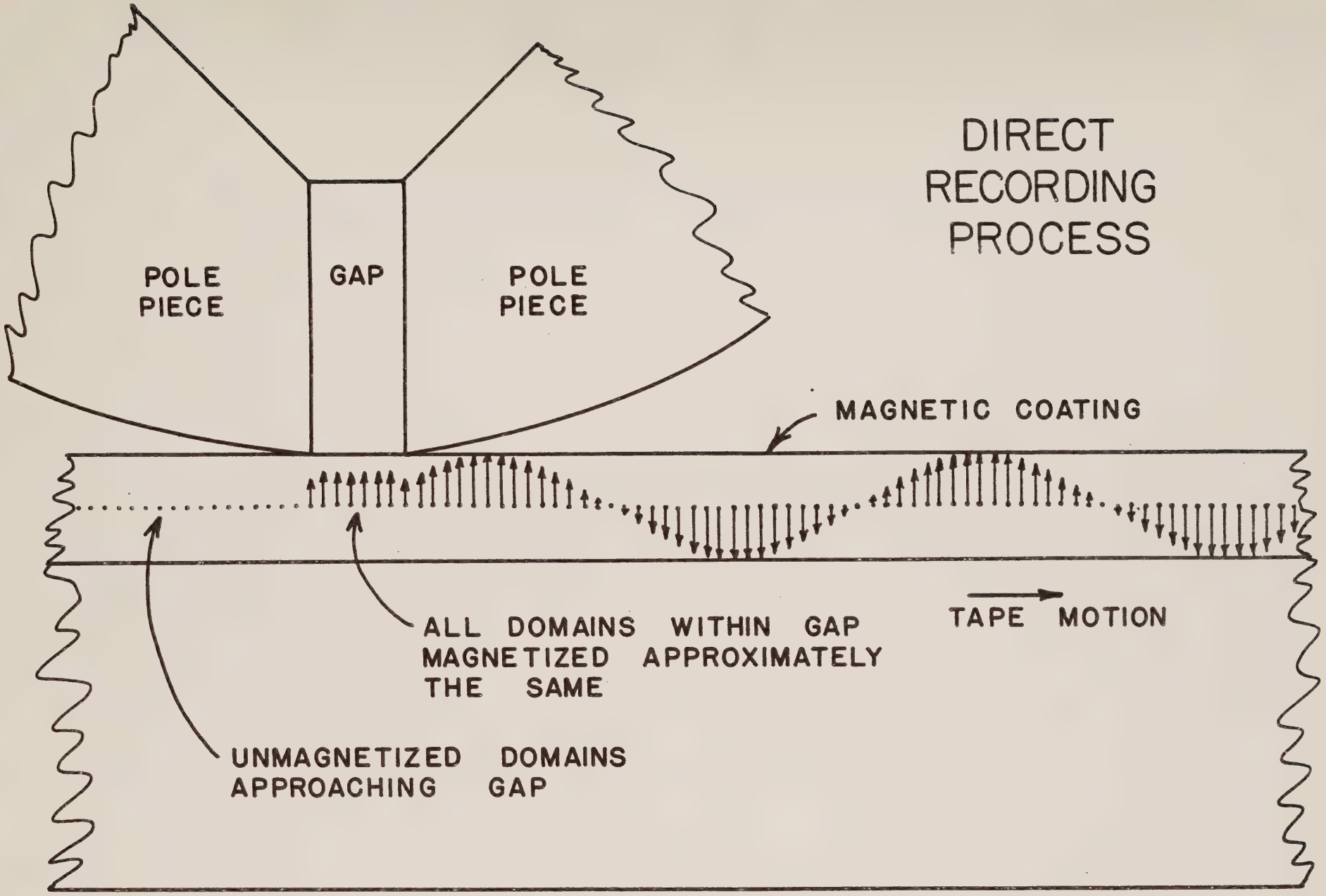
TYPICAL MAGNETIC HEAD

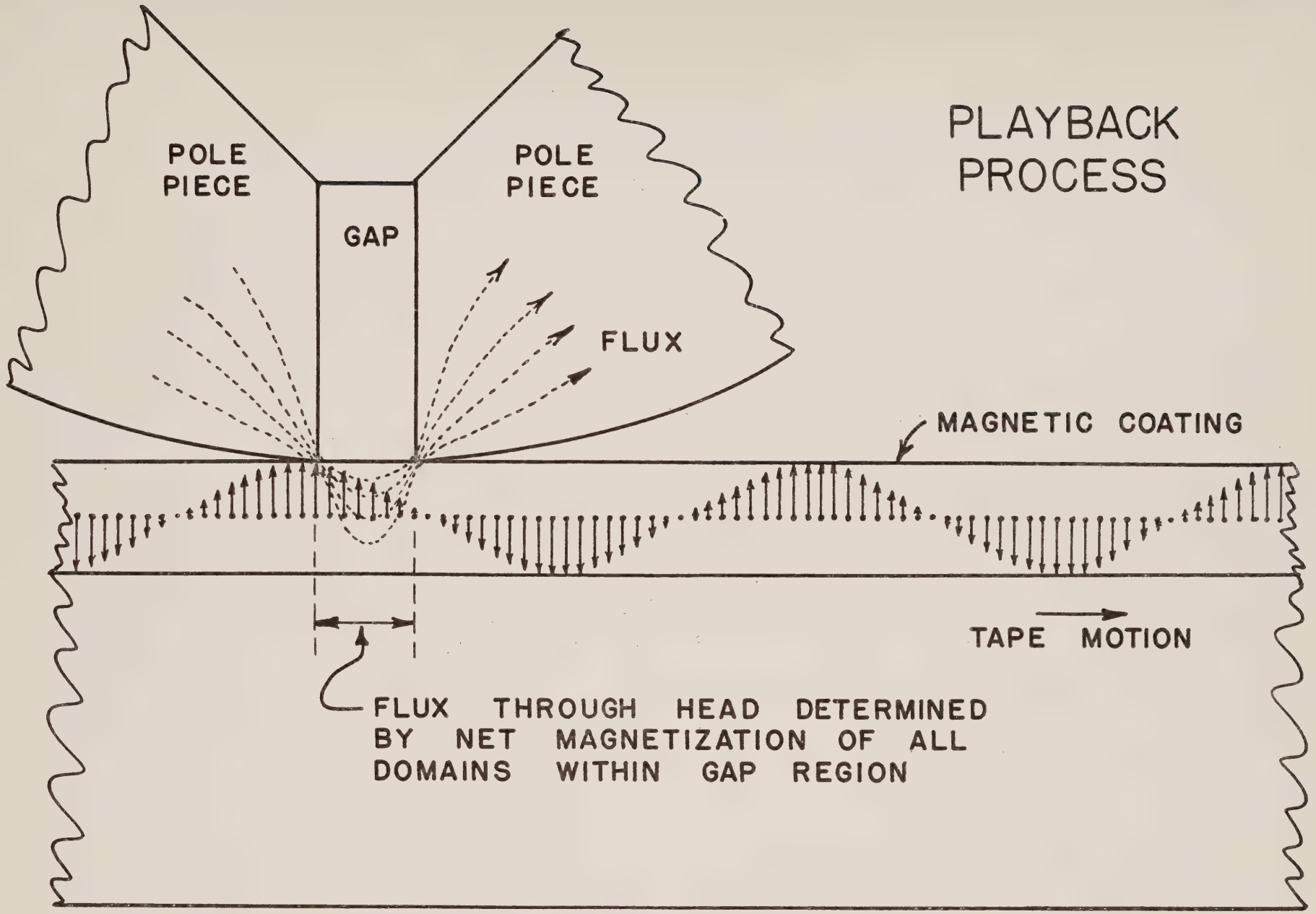


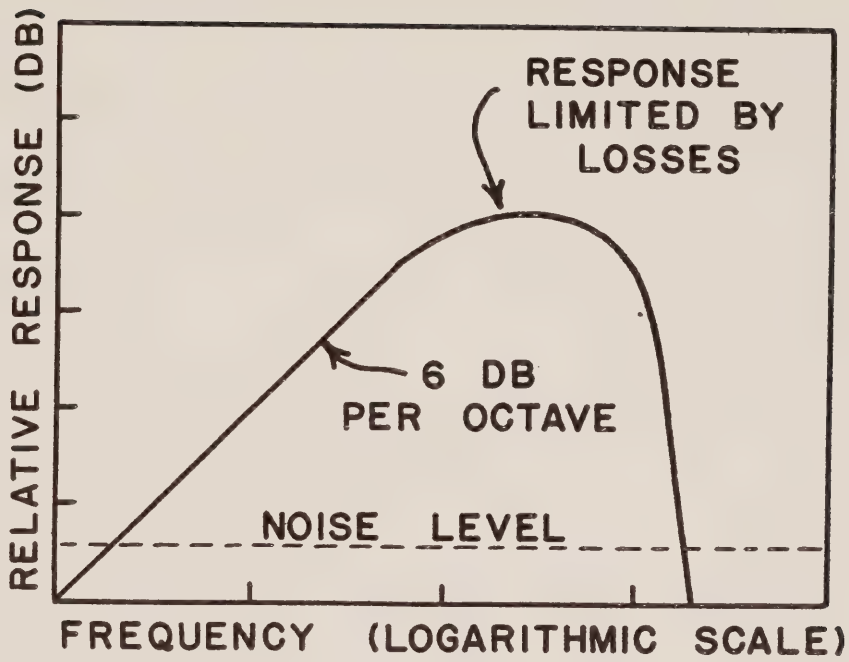
SIMPLIFIED SKETCH OF FLUX LINES IN A RECORDING GAP



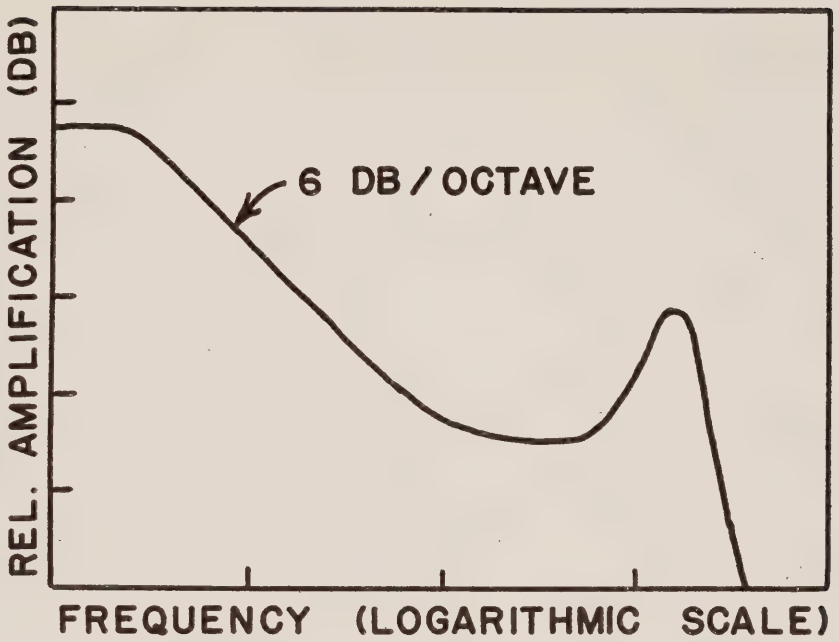
TYPICAL HYSTERESIS CURVE


DIRECT
RECORDING
PROCESS
POLE
PIECE
GAP
POLE
PIECE
MAGNETIC COATING
TAPE MOTION
ALL DOMAINS WITHIN GAP
MAGNETIZED APPROXIMATELY
THE SAME
UNMAGNETIZED DOMAINS
APPROACHING GAP


PLAYBACK PROCESS
POLE PIECE
GAP
POLE PIECE
FLUX
MAGNETIC COATING
TAPE MOTION
FLUX THROUGH HEAD DETERMINED BY NET MAGNETIZATION OF ALL DOMAINS WITHIN GAP REGION

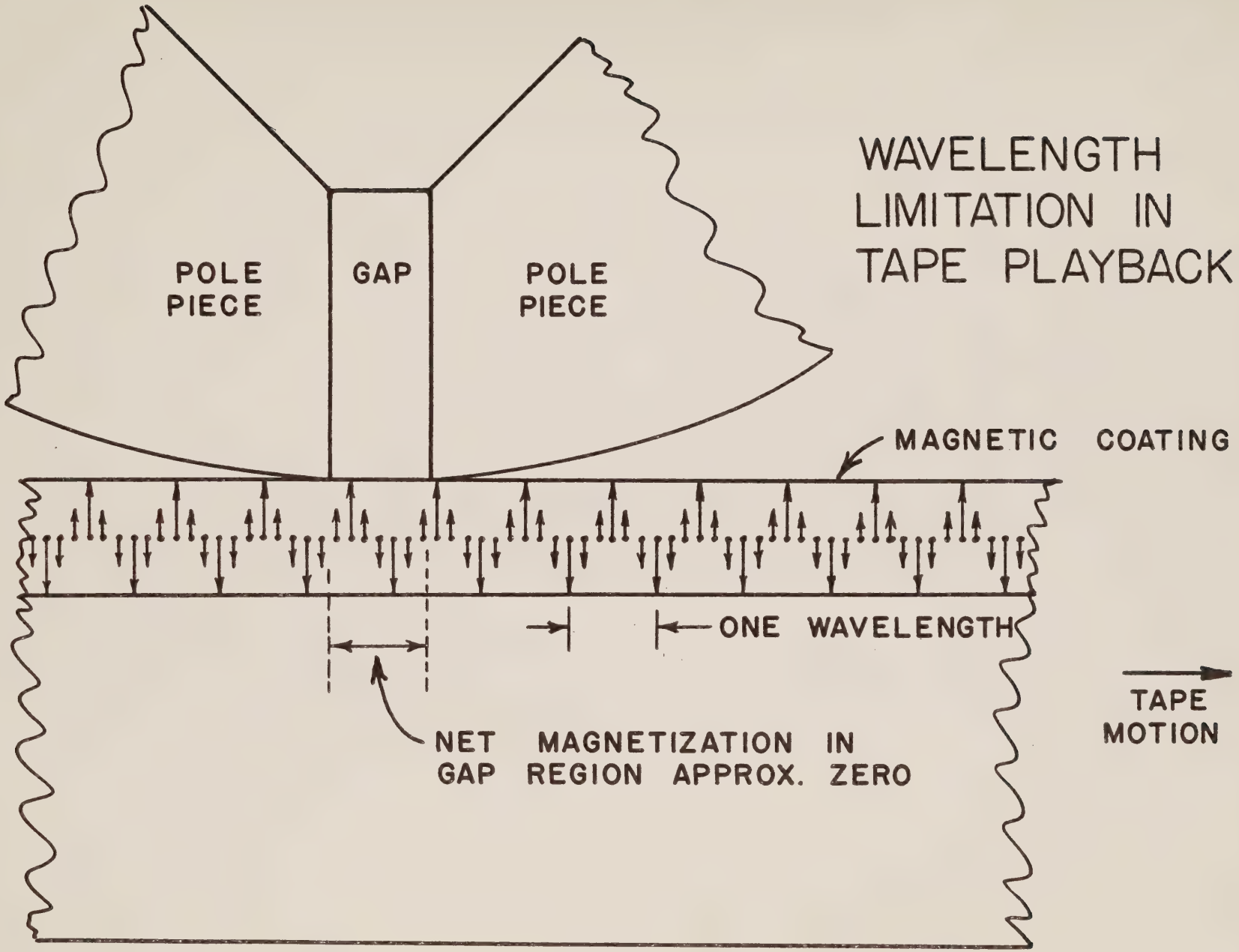


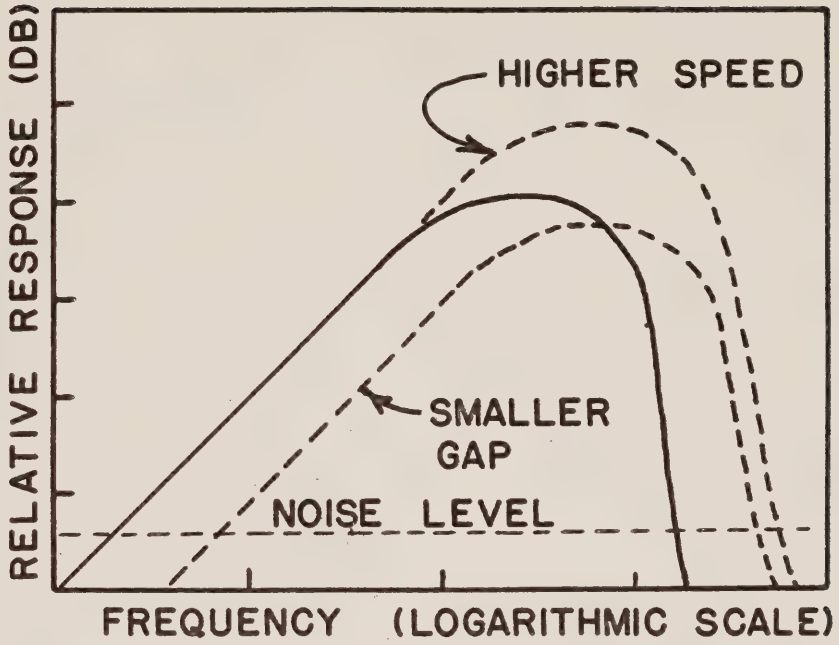
TYPICAL RESPONSE CURVE



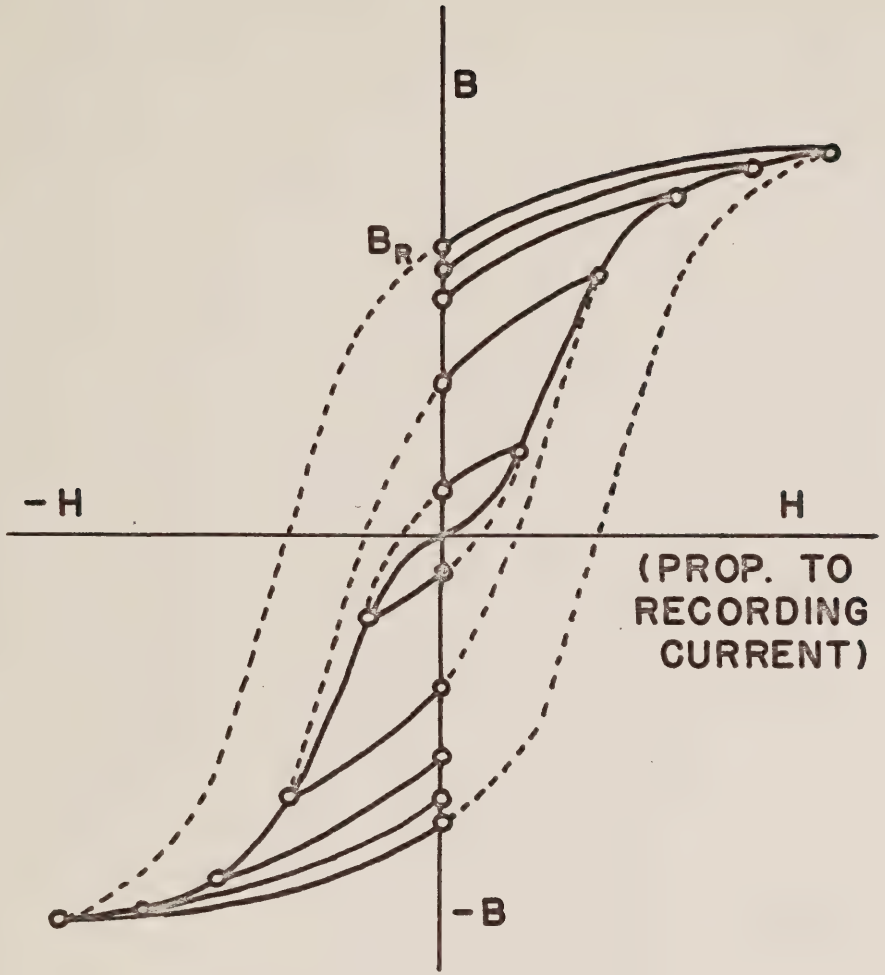
TYPICAL EQUALIZATION CURVE

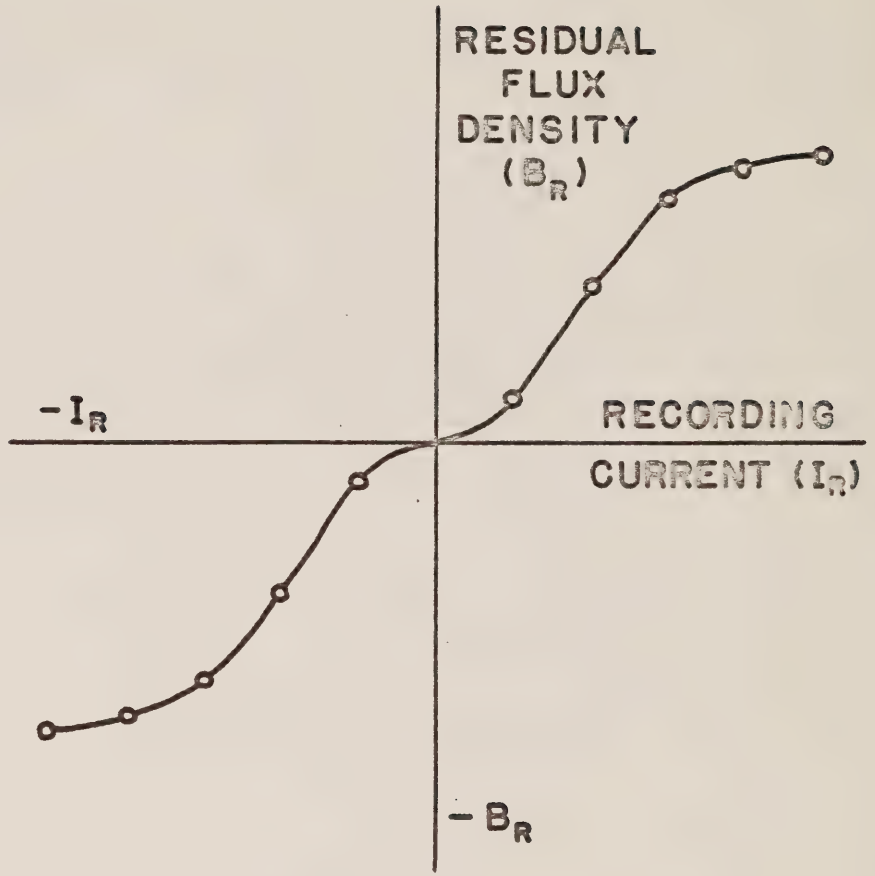
WAVELENGTH LIMITATION IN TAPE PLAYBACK



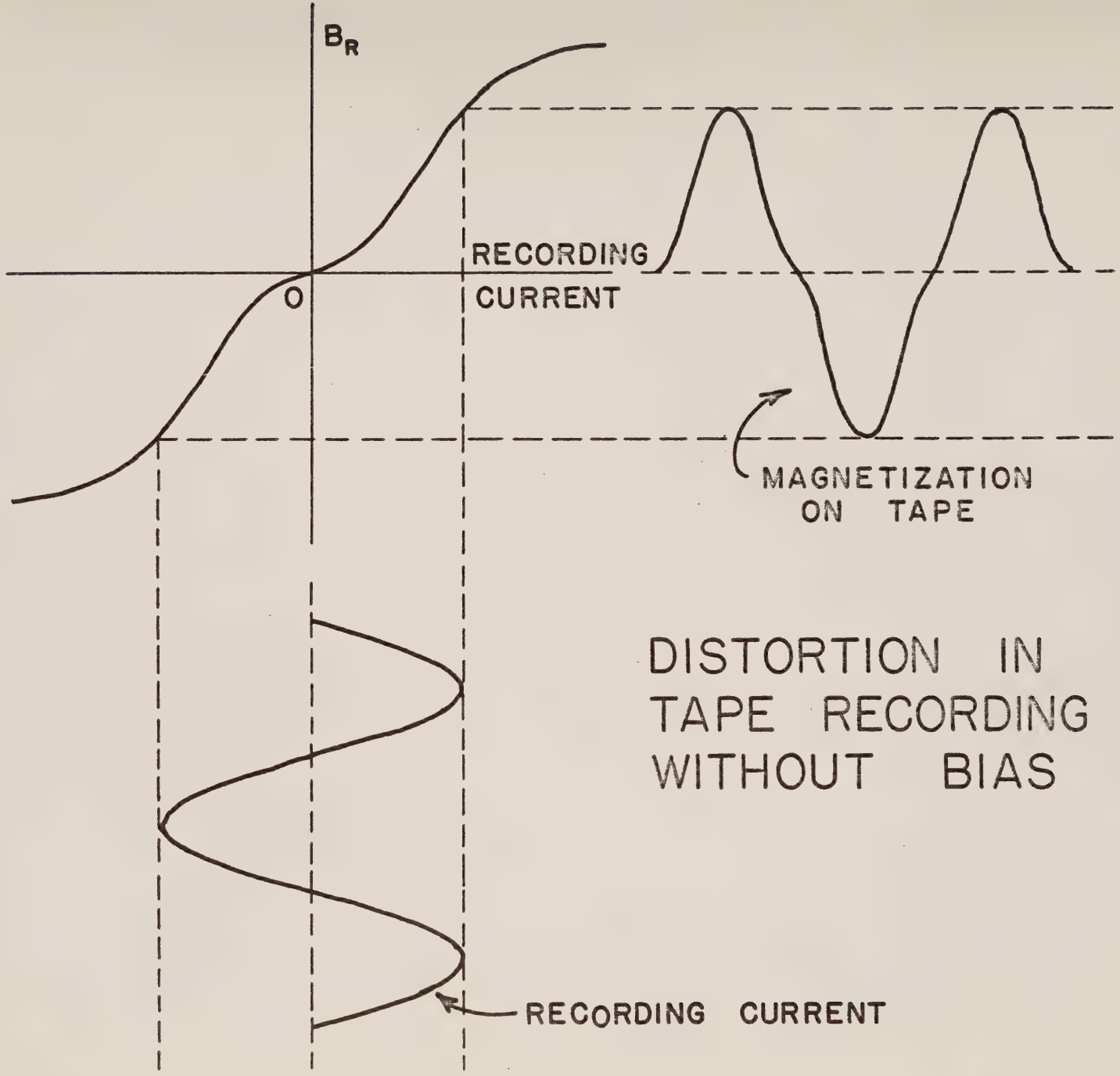


EXTENSION OF FREQUENCY RESPONSE

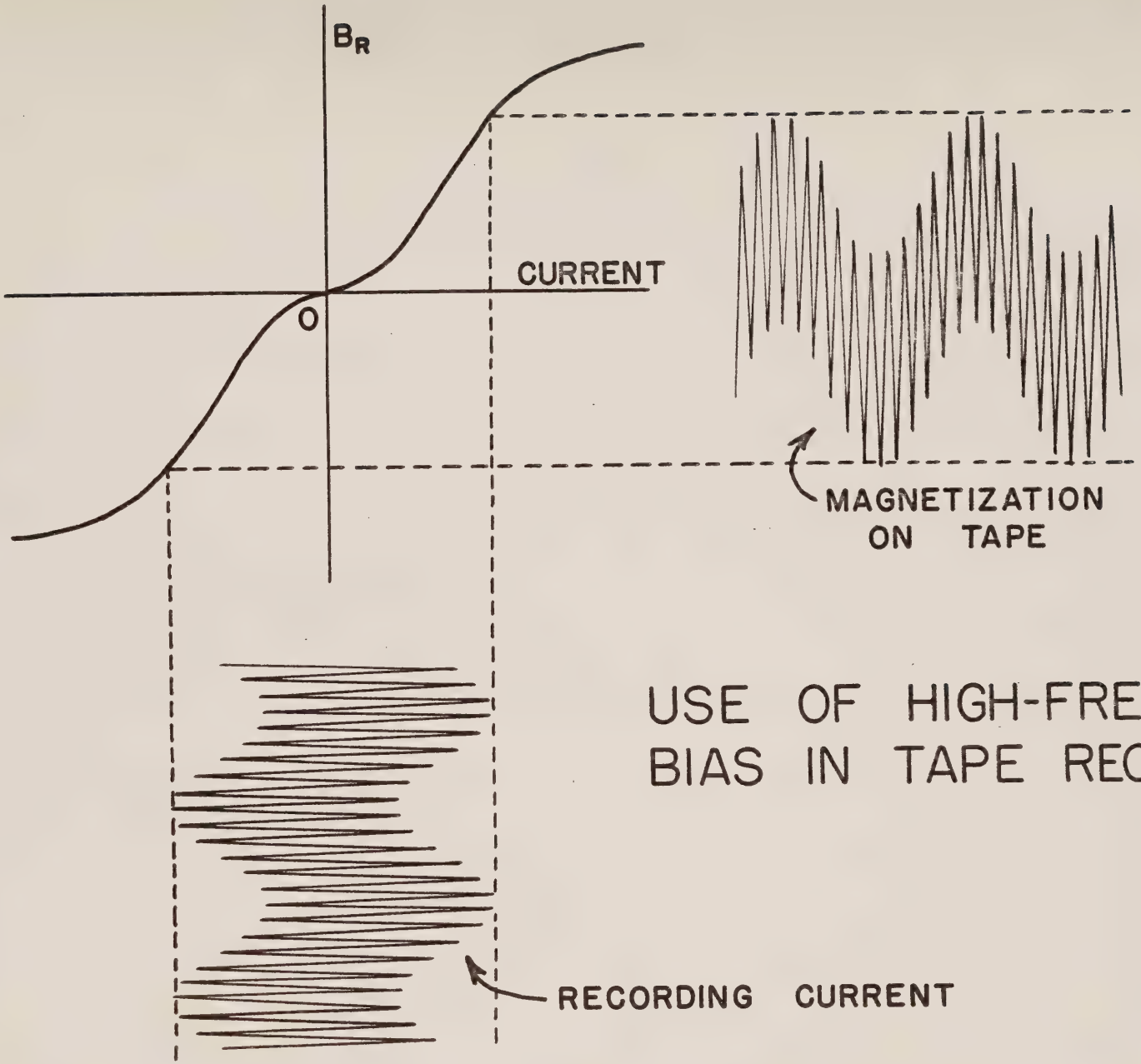




DERIVATION OF TAPE TRANSFER CHARACTERISTIC

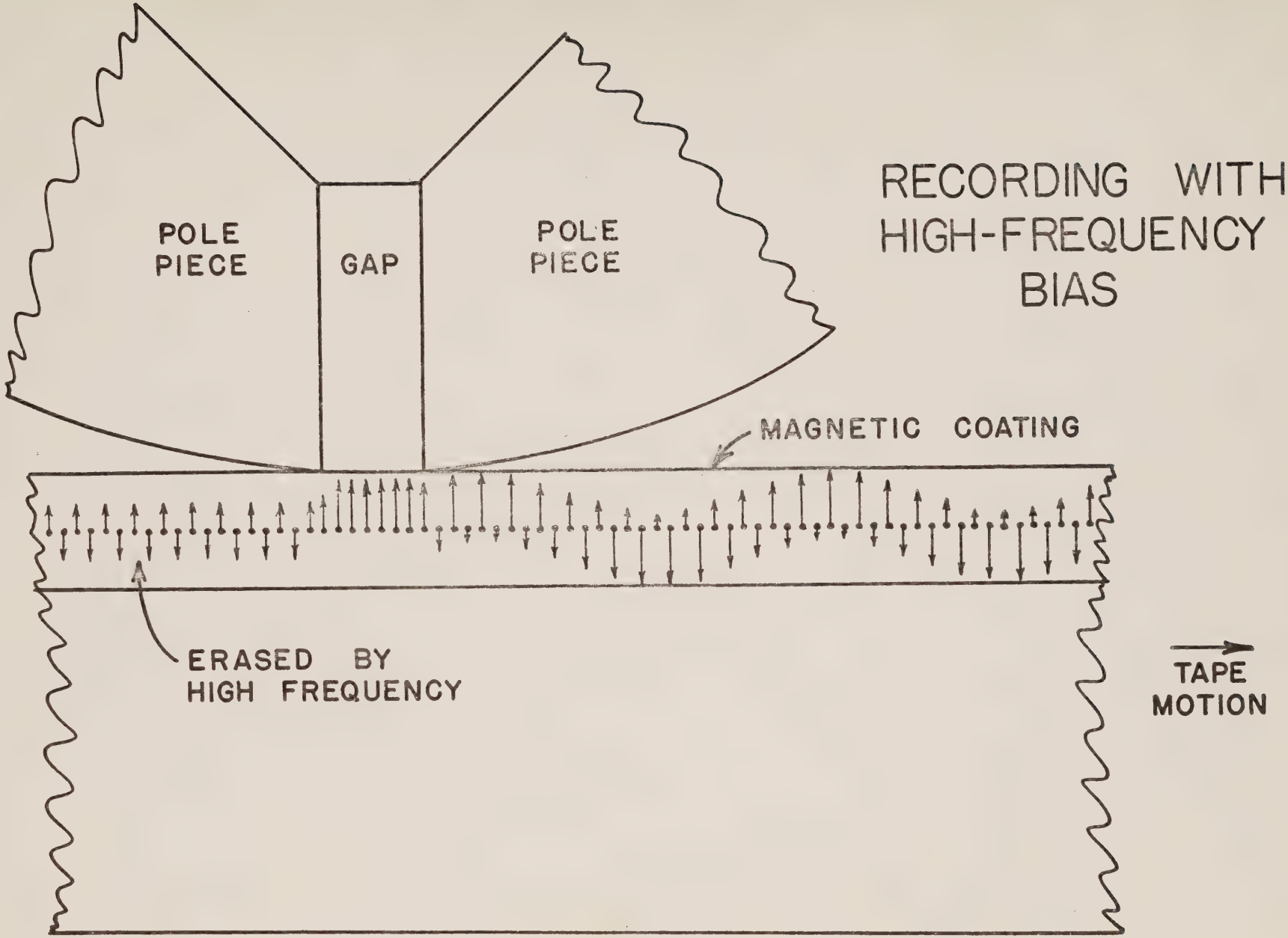


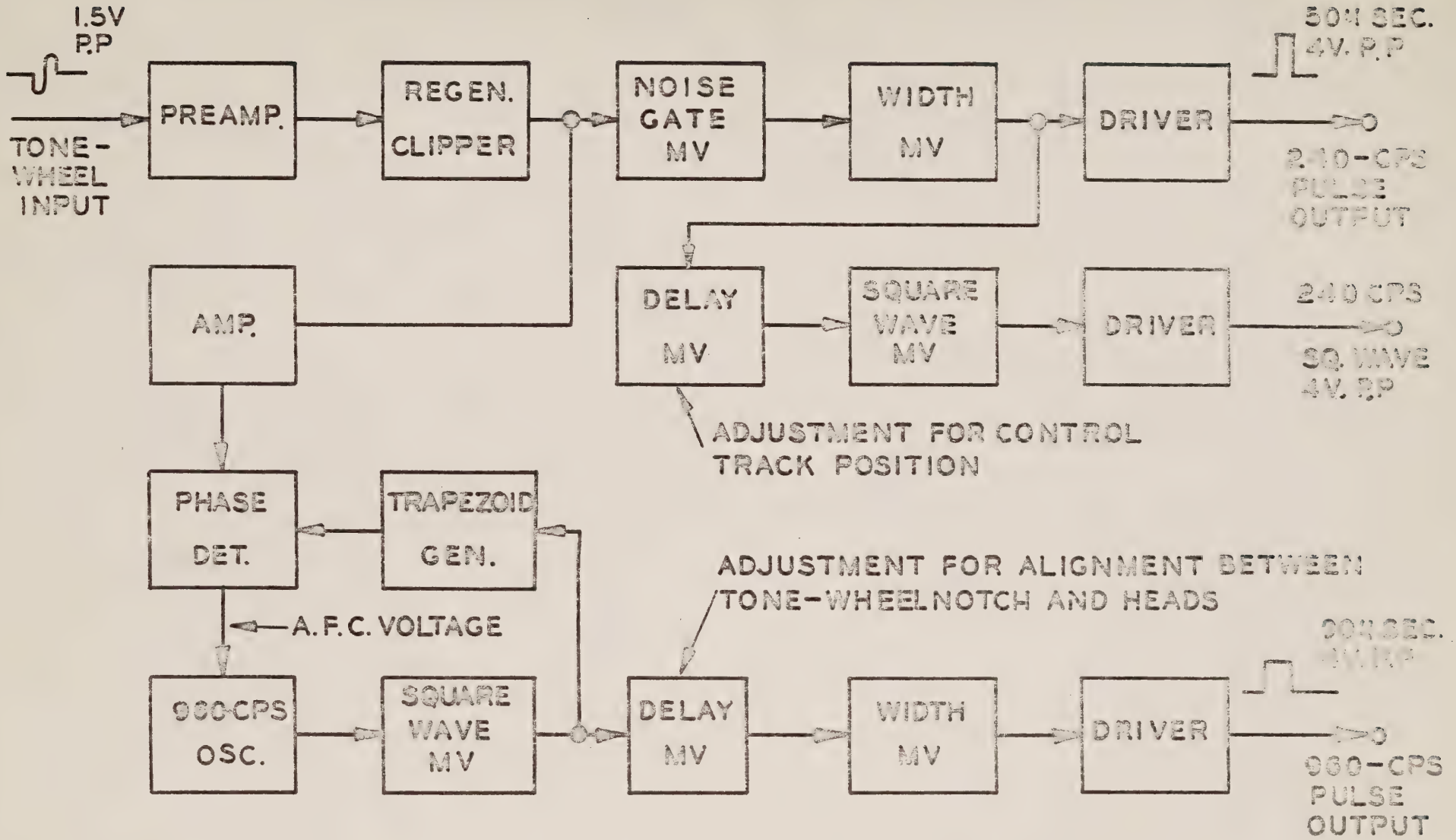
DISTORTION IN TAPE RECORDING WITHOUT BIAS



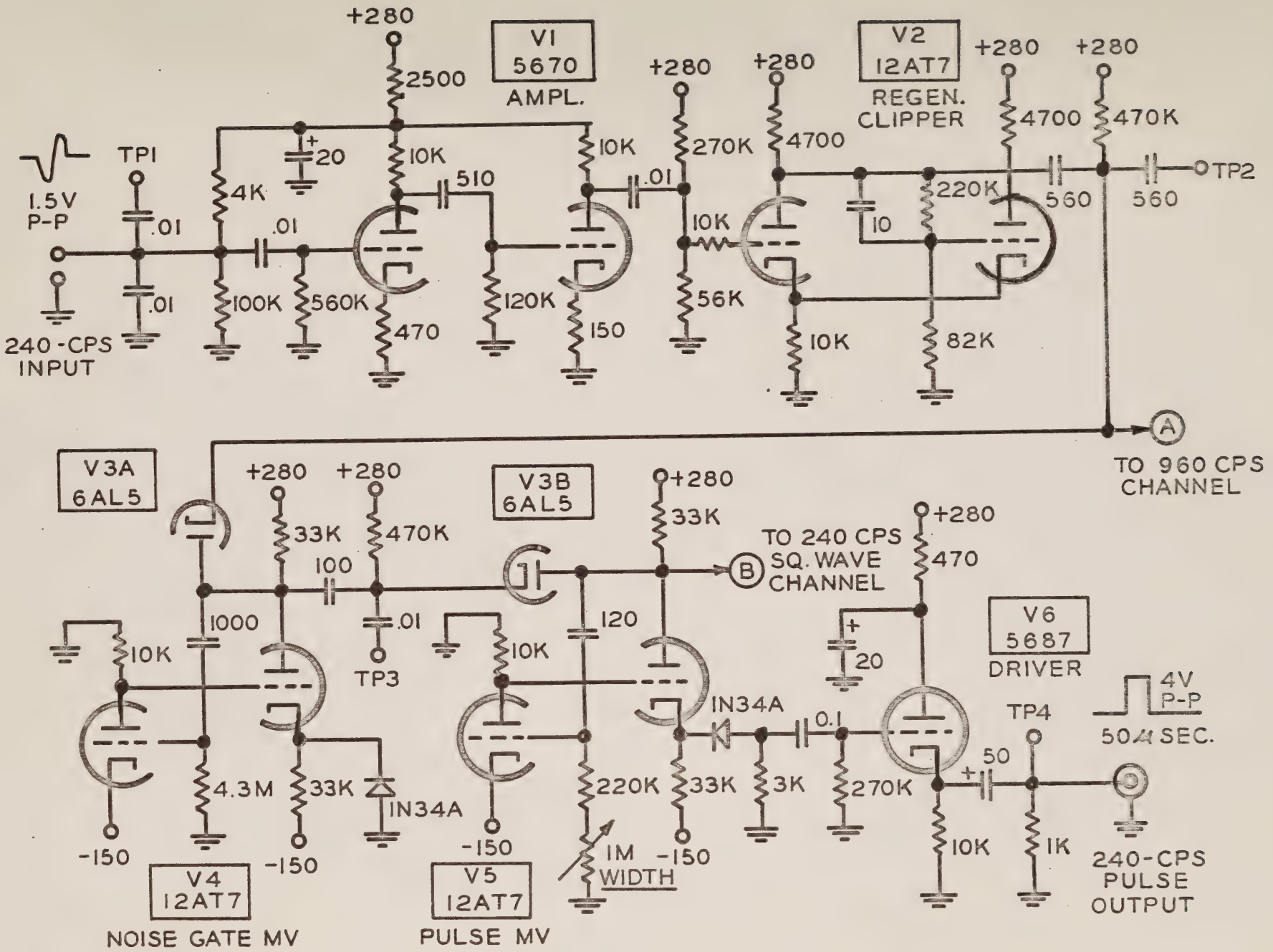
USE OF HIGH-FREQUENCY BIAS IN TAPE RECORDING

RECORDING WITH HIGH-FREQUENCY BIAS

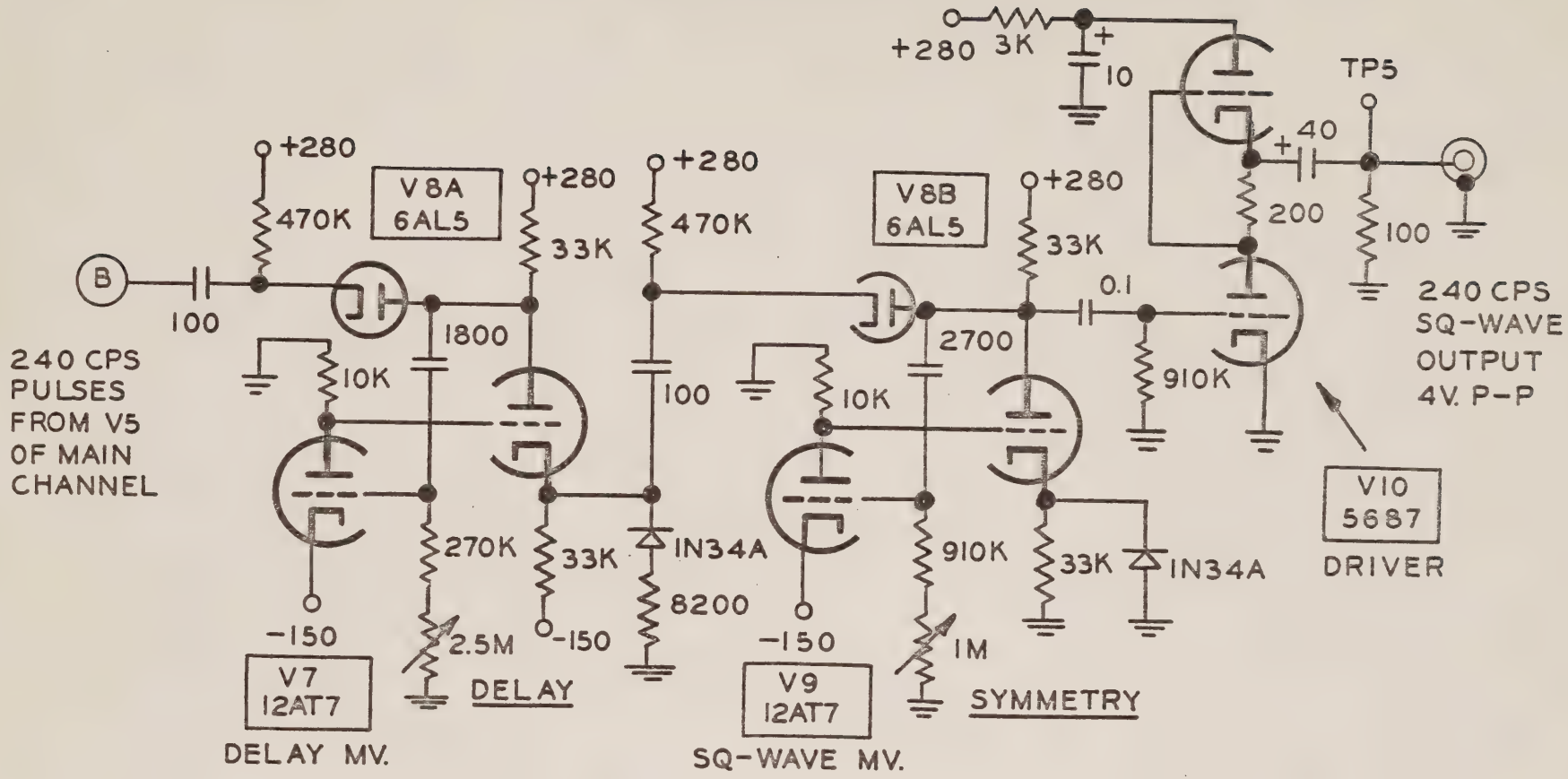




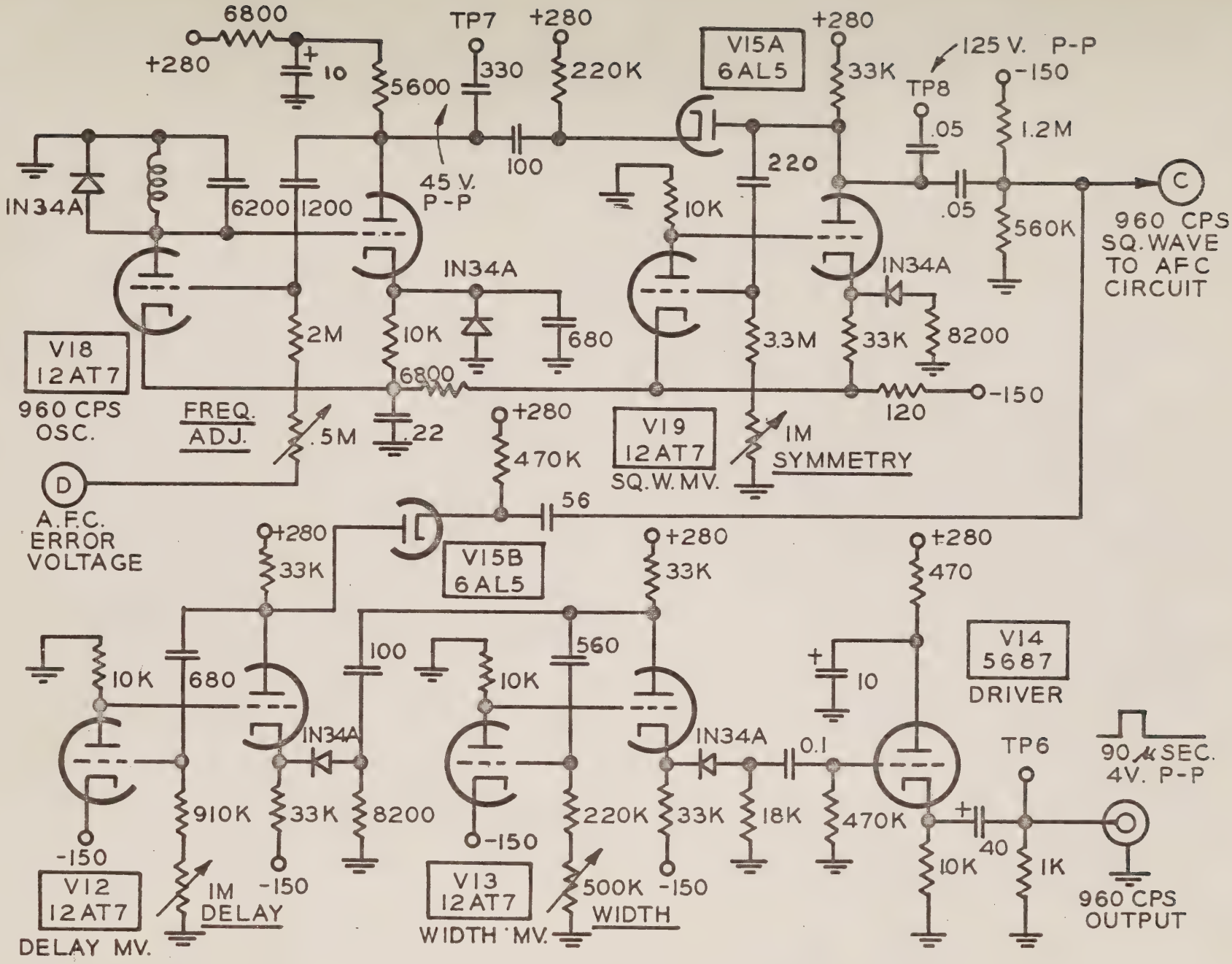
BLOCK DIAGRAM OF TONE-WHEEL AMPLIFIER



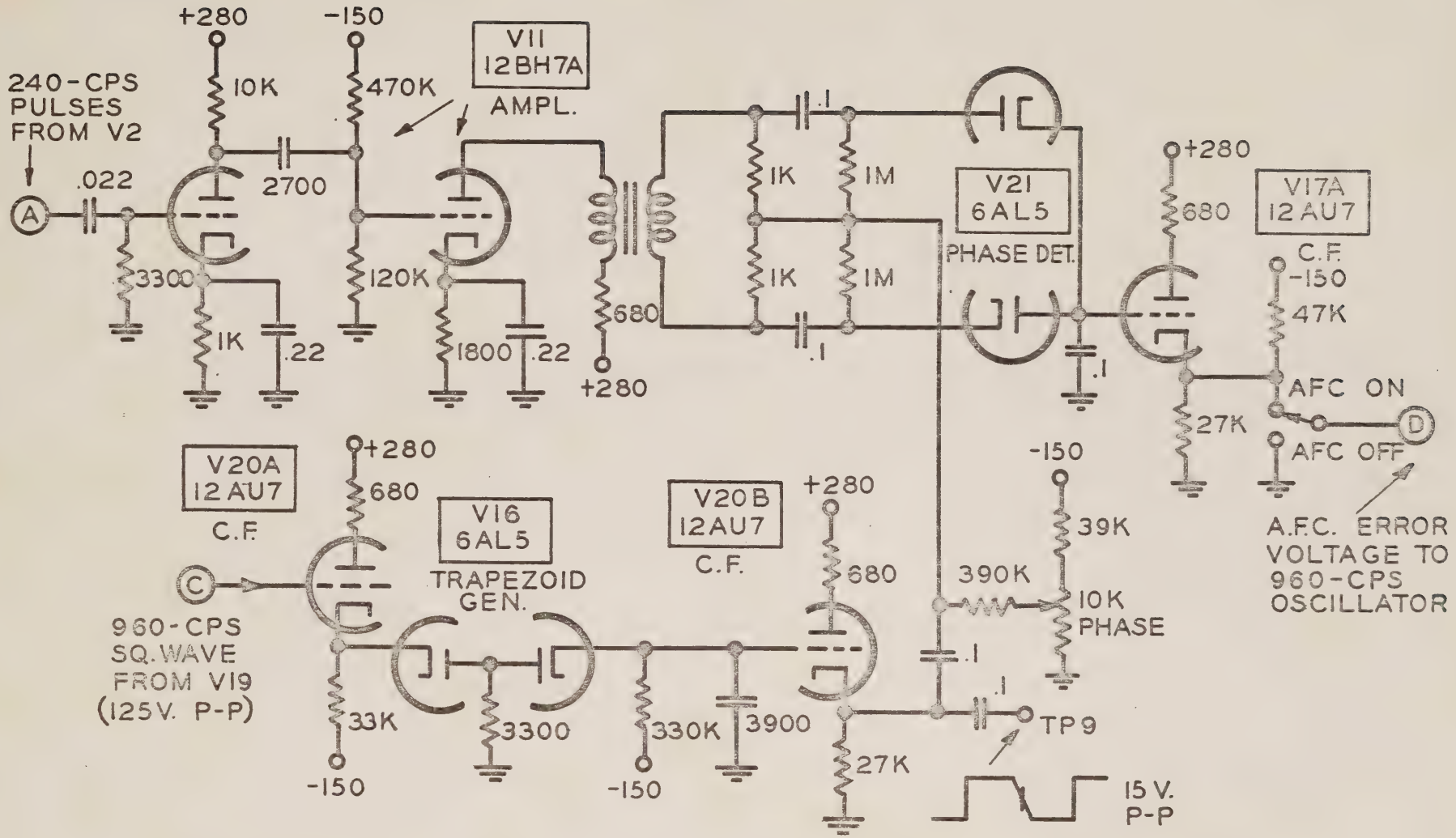
MAIN CHANNEL OF TONE-WHEEL AMPLIFIER



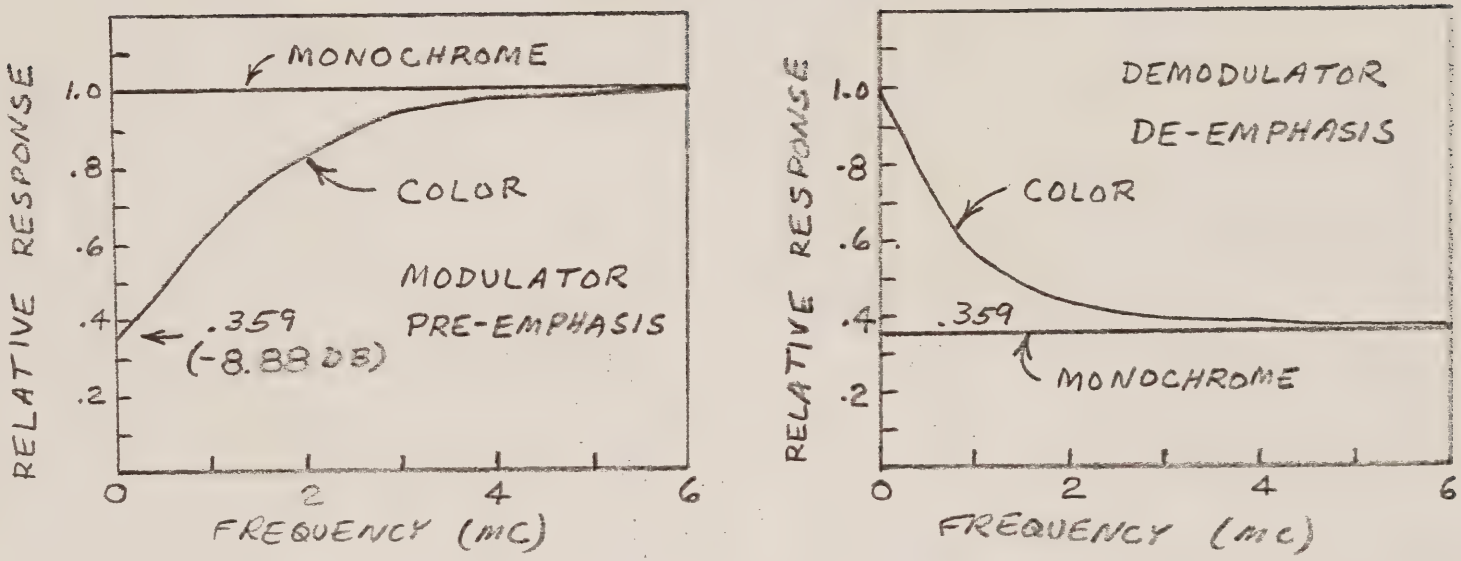
240-CPS SQUARE-WAVE CHANNEL OF TONE-WHEEL AMPLIFIER



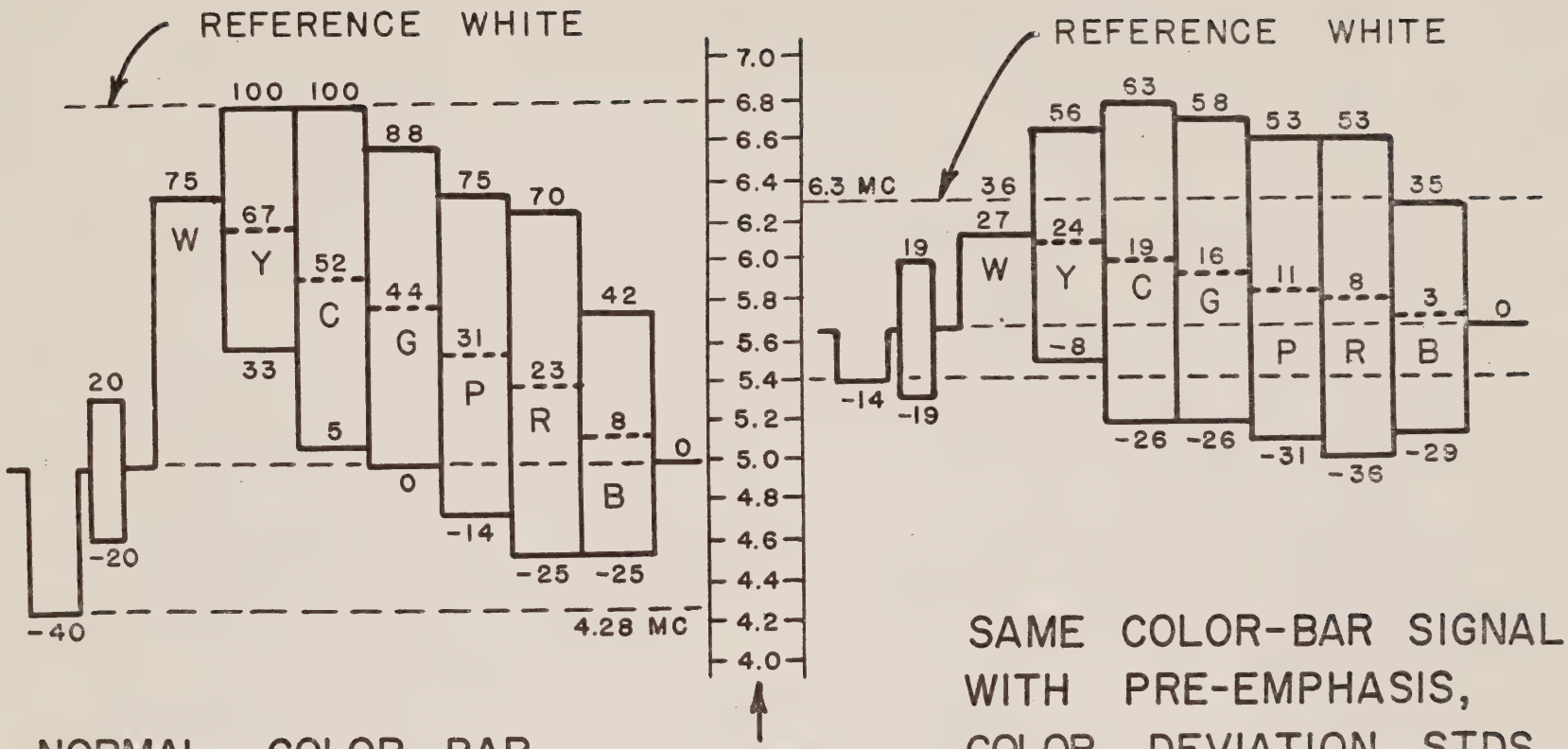
960-CPS CHANNEL OF TONE-WHEEL AMPLIFIER



AUTOMATIC-FREQUENCY-CONTROL CIRCUIT FOR 960-CPS CHANNEL OF TONE-WHEEL AMPLIFIER



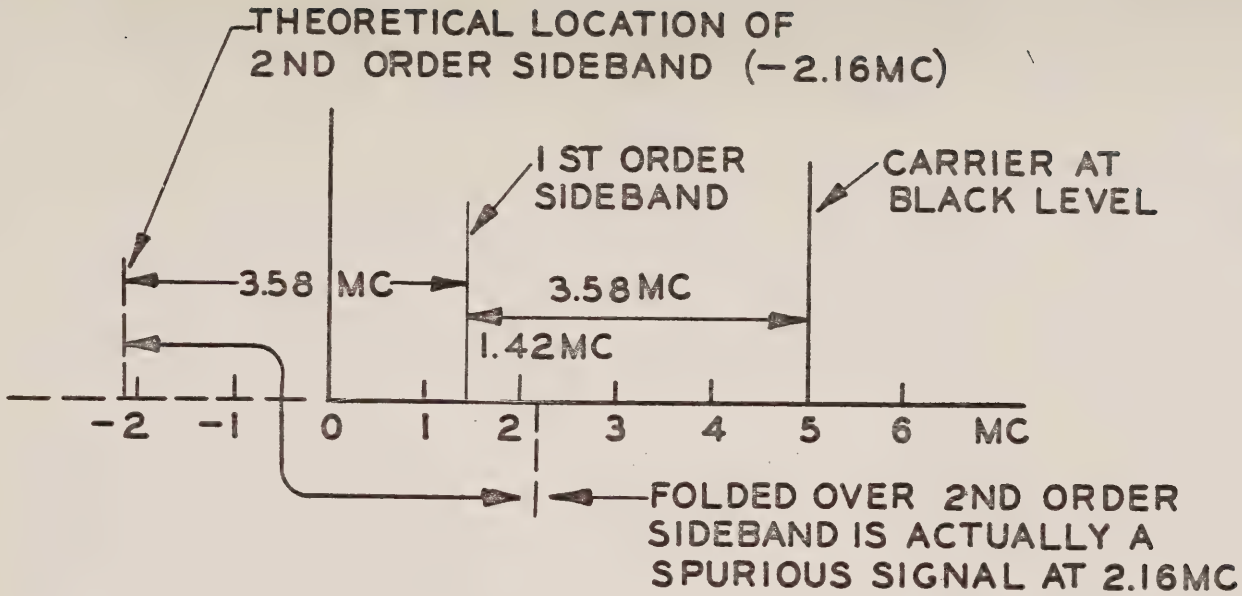
FREQUENCY RESPONSE CHARACTERISTICS OF MODULATOR AND DEMODULATOR



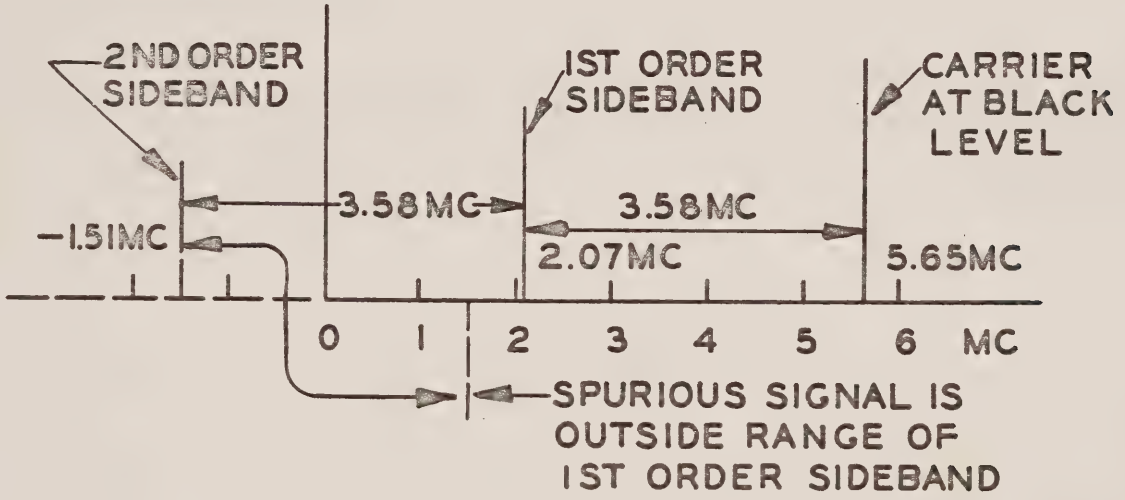
NORMAL COLOR-BAR SIGNAL, MONOCHROME DEVIATION STANDARDS
(Numerals show IRE scale readings.)

F-M DEVIATION SCALE (MC)

SAME COLOR-BAR SIGNAL WITH PRE-EMPHASIS, COLOR DEVIATION STDS.
(IRE scale calibrated for monochrome, transient disturbances omitted for clarity.)

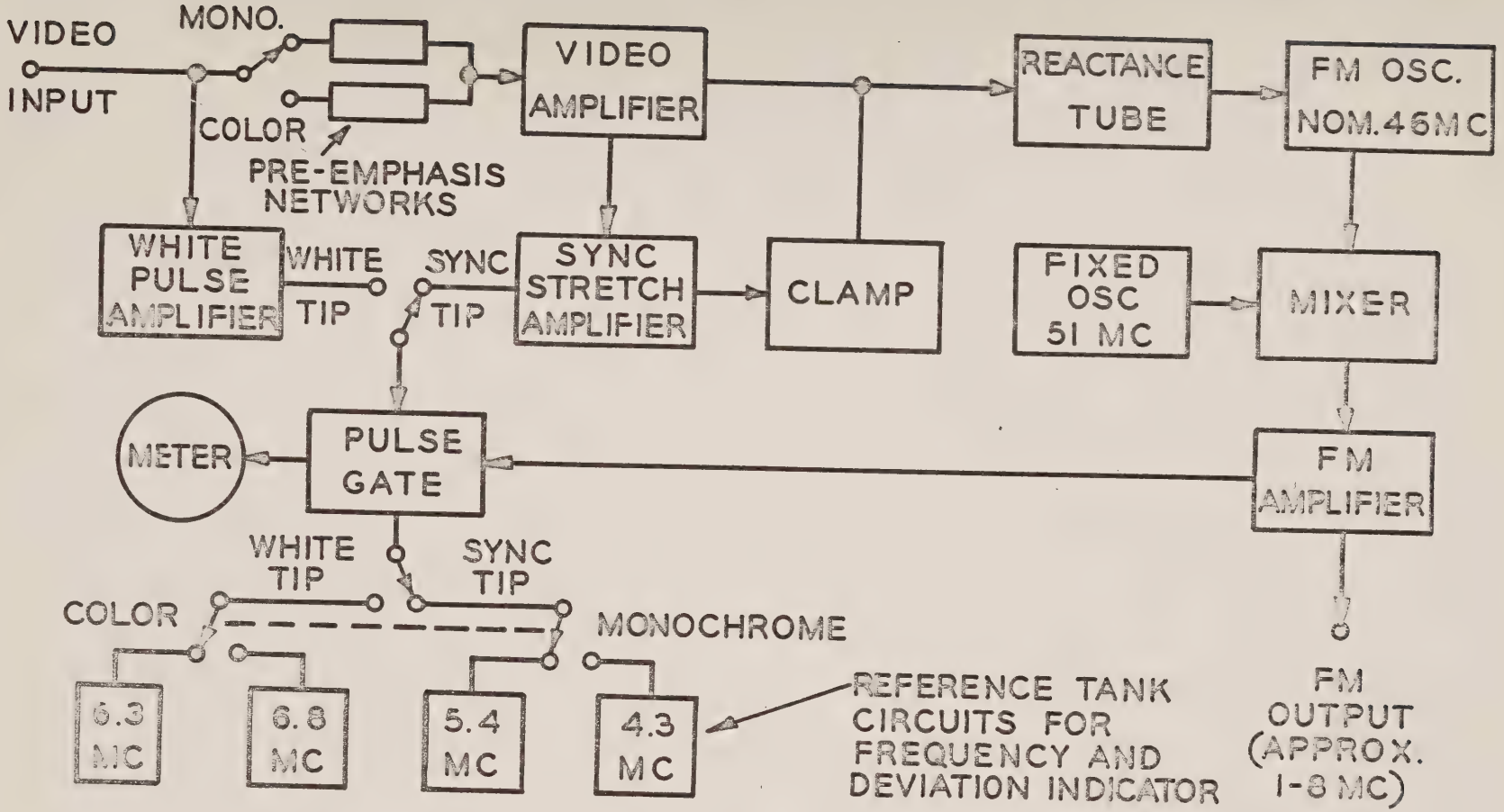


MONOCHROME DEVIATION STANDARDS

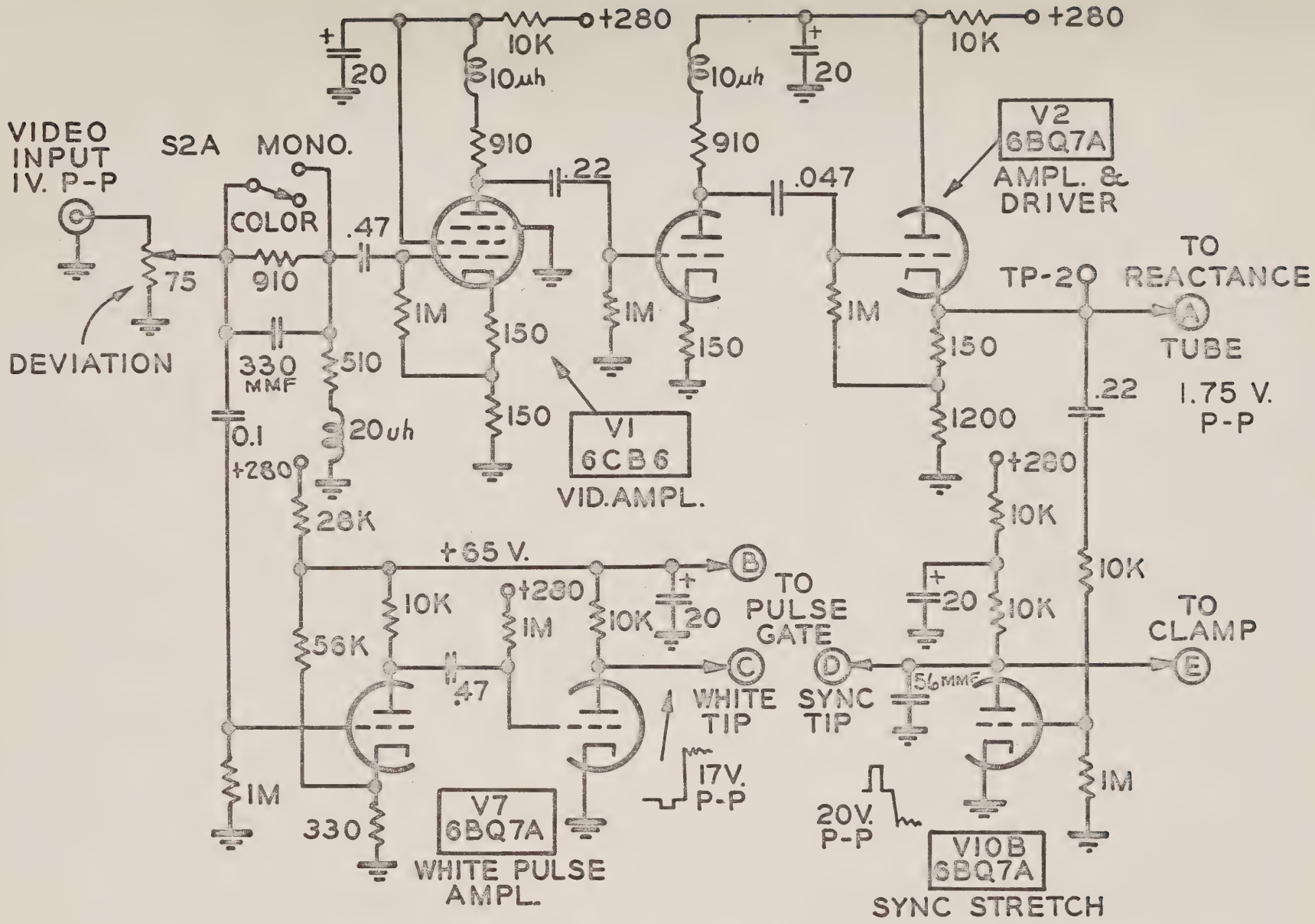


COLOR DEVIATION STANDARDS

SPECTRUM SKETCHES ILLUSTRATING SIDEBAND STRUCTURE OF COLOR TV SIGNALS IN TV TAPE RECORDING

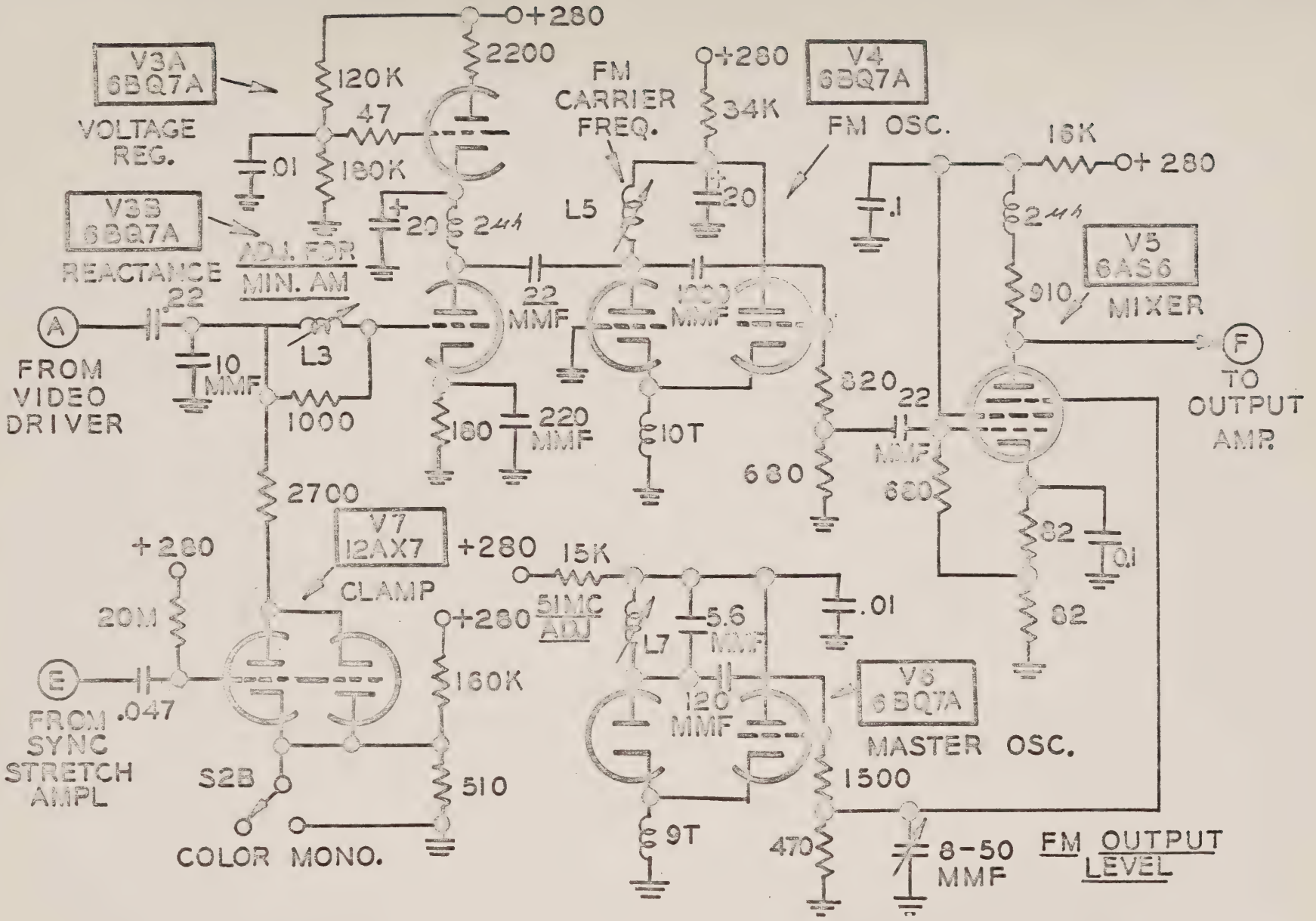


SIMPLIFIED BLOCK DIAGRAM OF TRT-IA MODULATOR

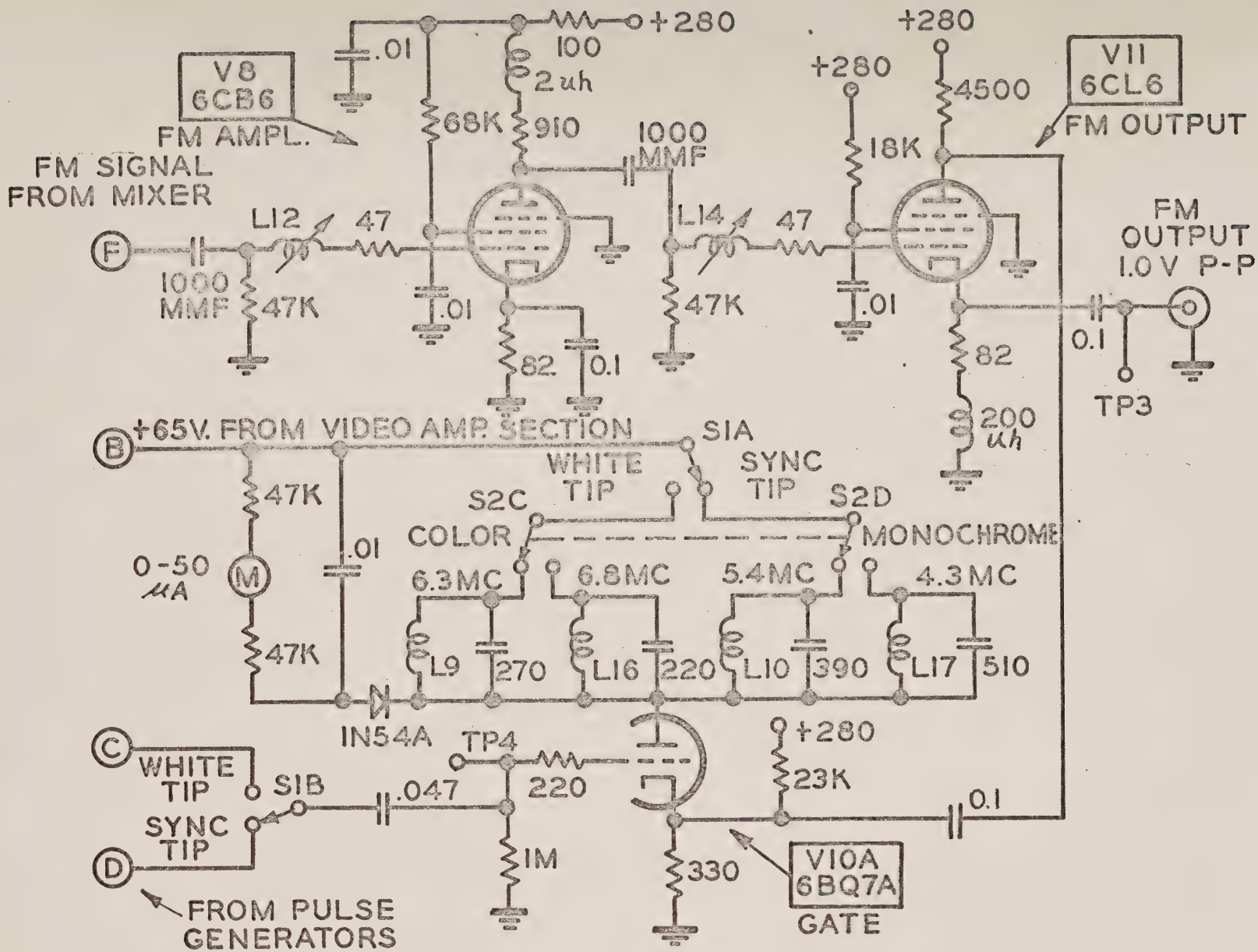


4-7

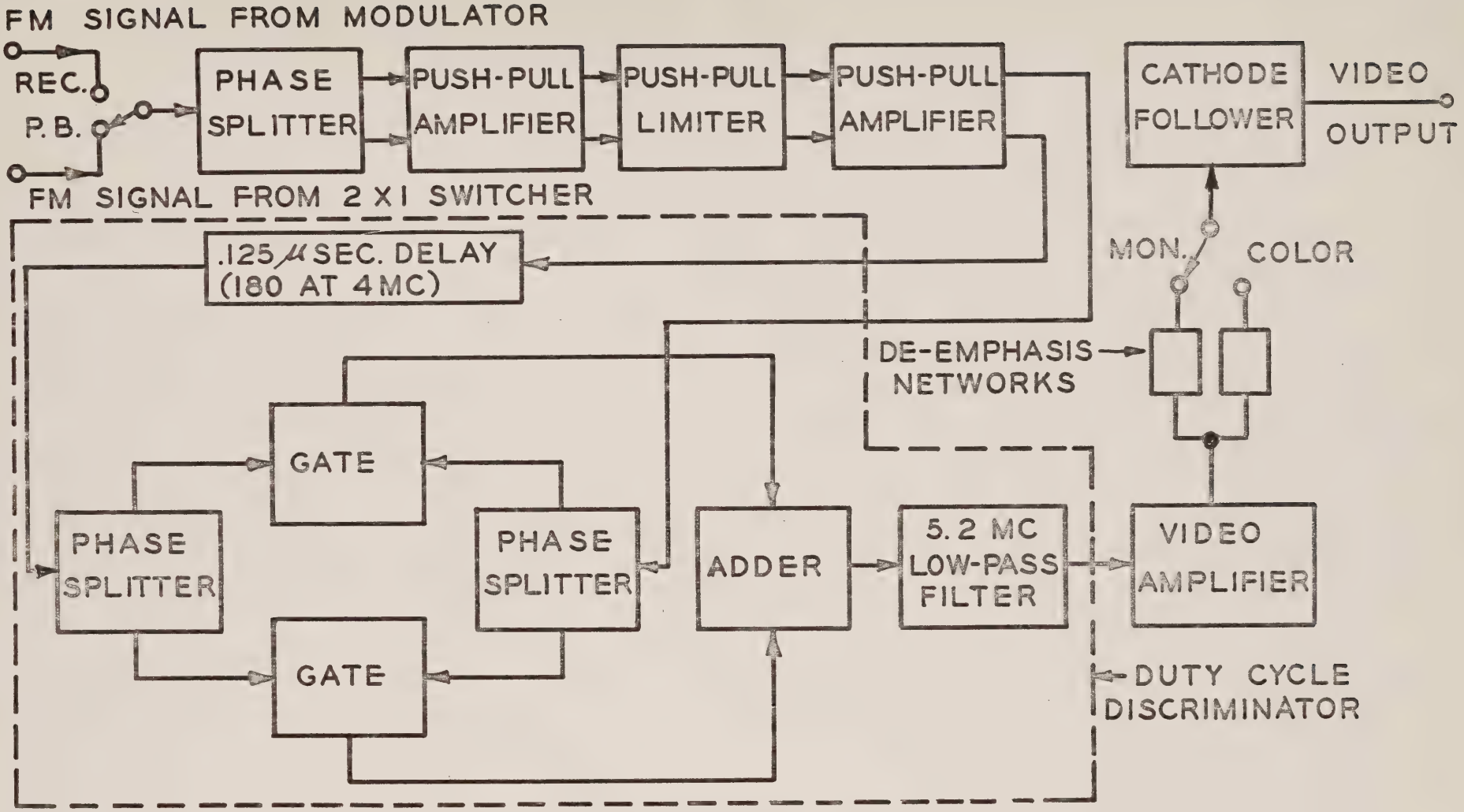
VIDEO AMPLIFIER AND SAMPLING PULSE GENERATOR SECTIONS OF TRT-1A MODULATOR



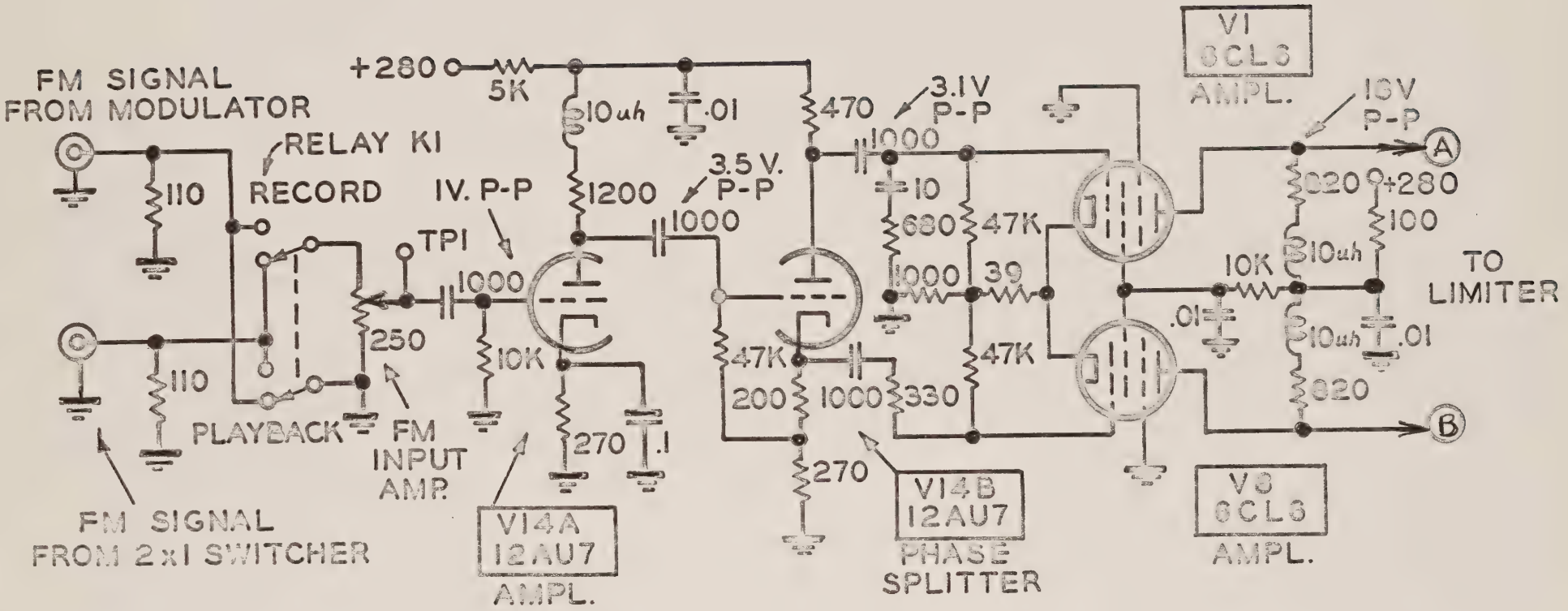
4-8 OSCILLATOR AND MIXER SECTION OF TRT-1A MODULATOR



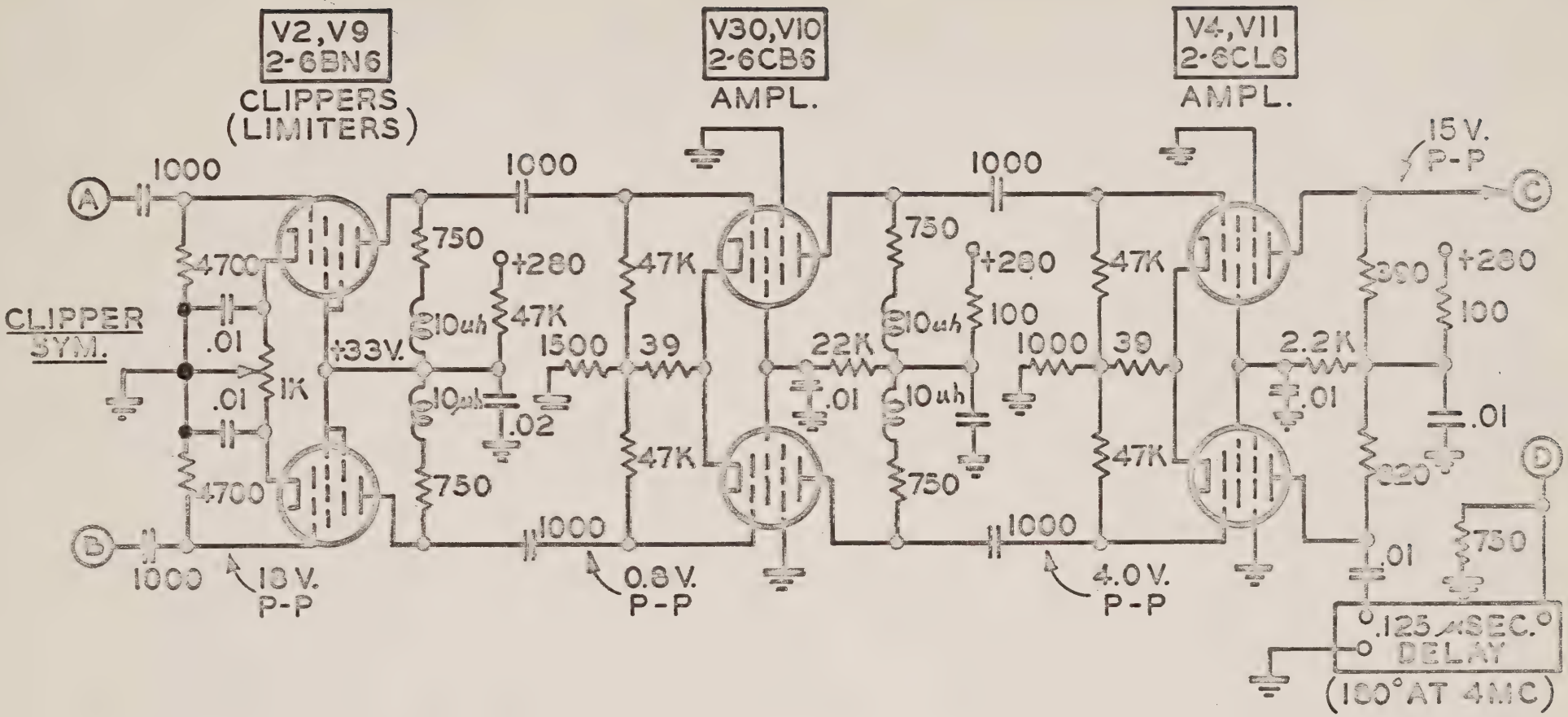
OUTPUT AMPLIFIER AND FREQUENCY INDICATOR FOR TRT-1A MODULATOR



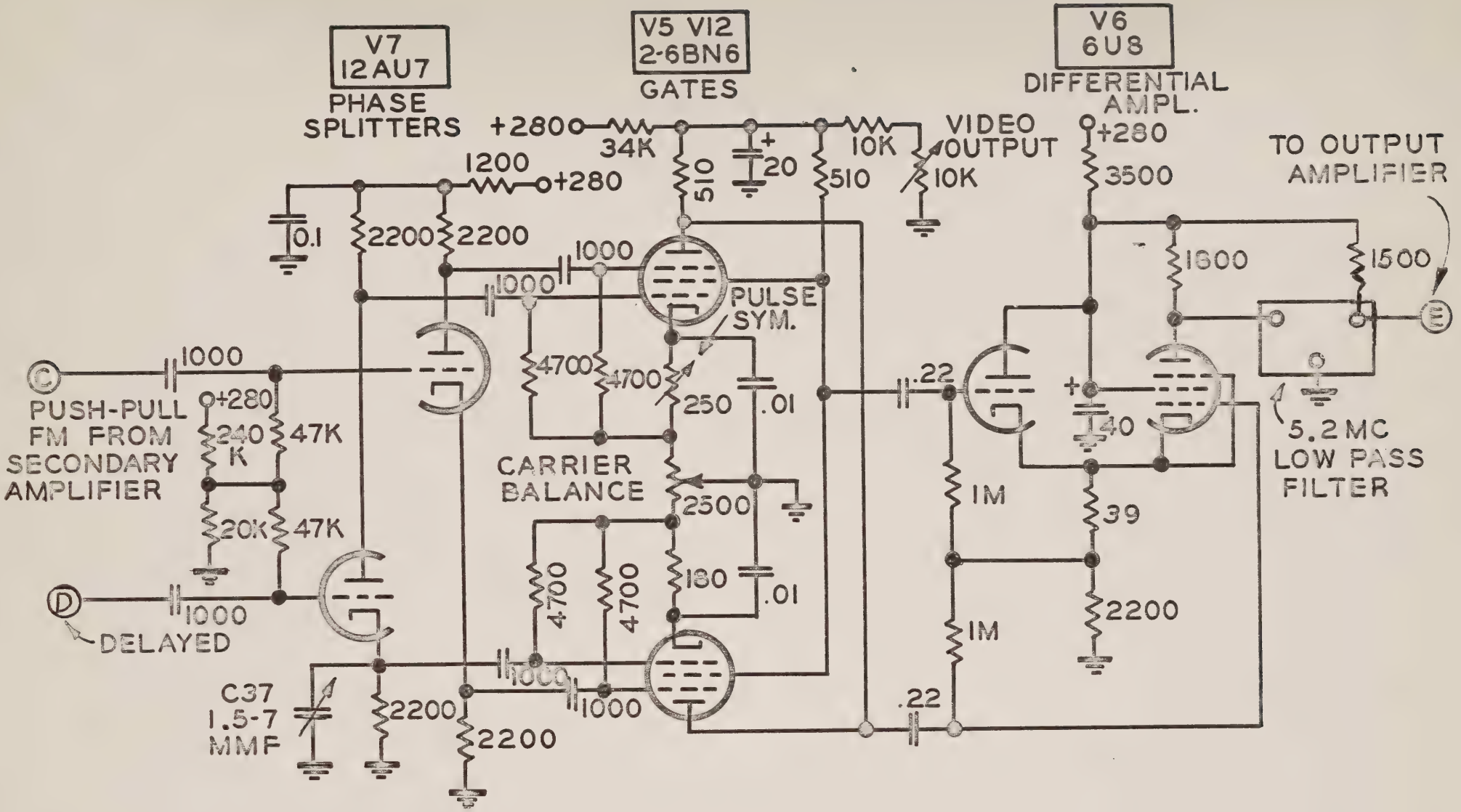
SIMPLIFIED BLOCK DIAGRAM OF TRT-IA/IAC DEMODULATOR



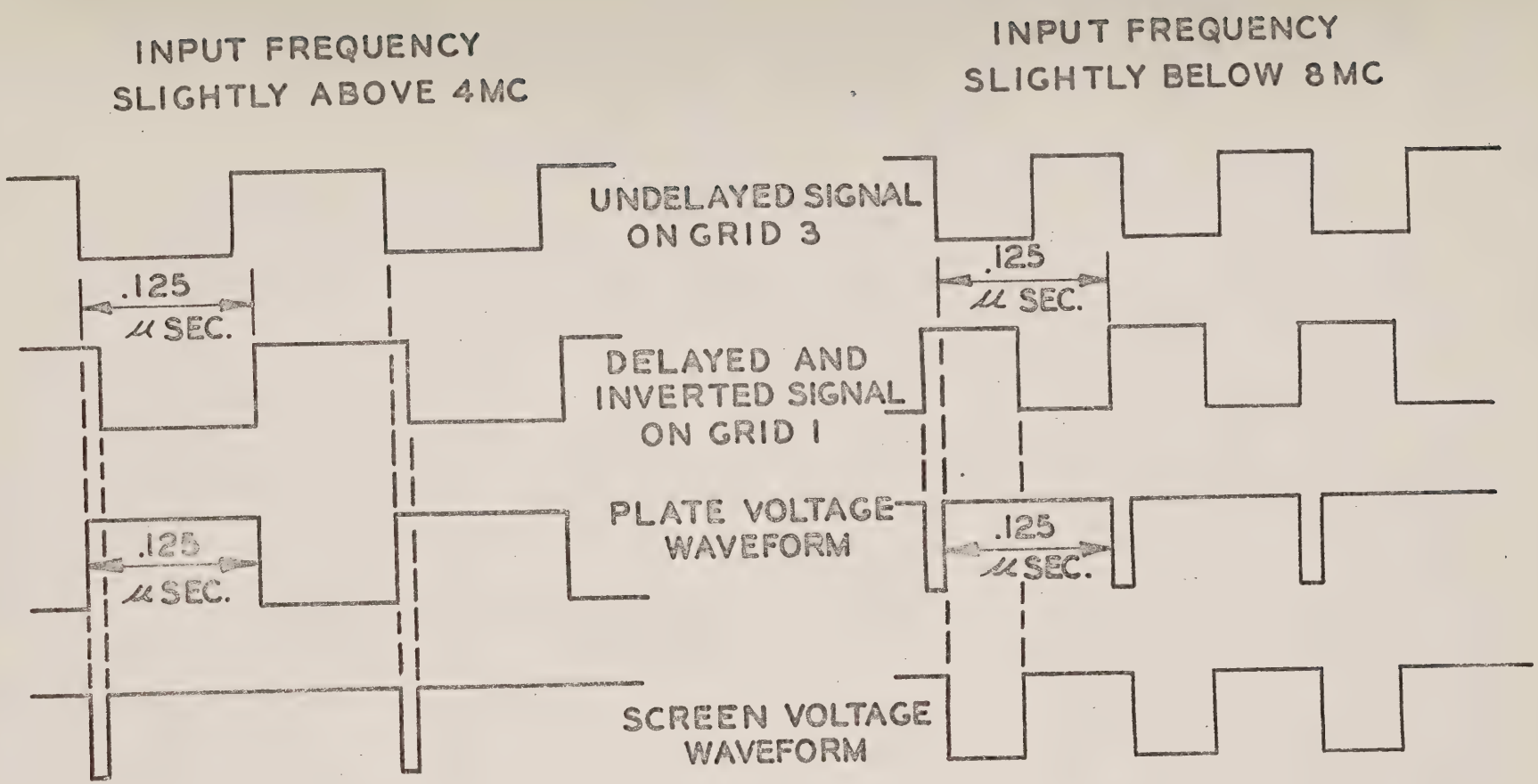
INPUT AMPLIFIER SECTION OF TRT-1A DEMODULATOR



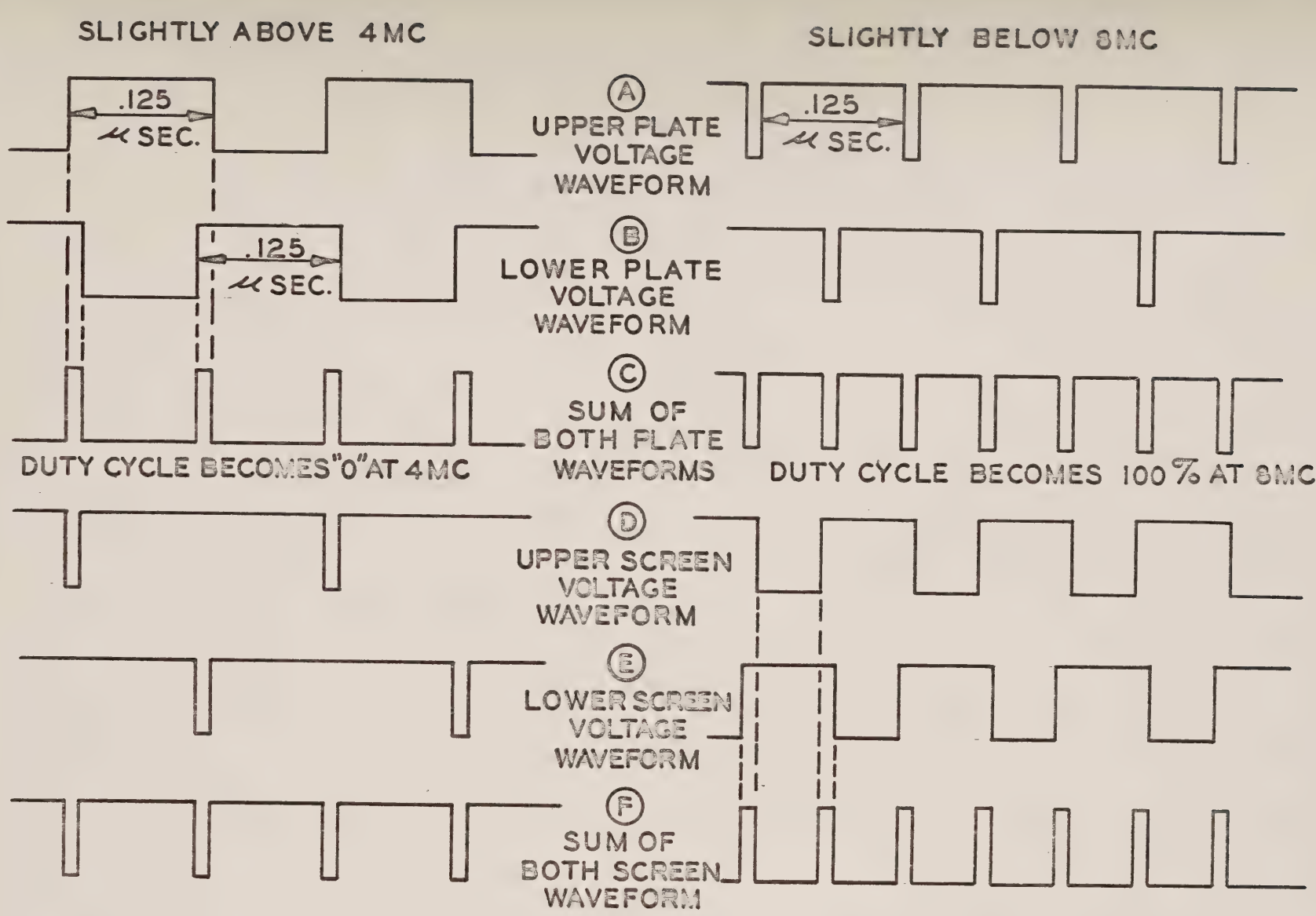
LIMITER AND SECONDARY AMPLIFIER SECTION
OF TRT-IA DEMODULATOR



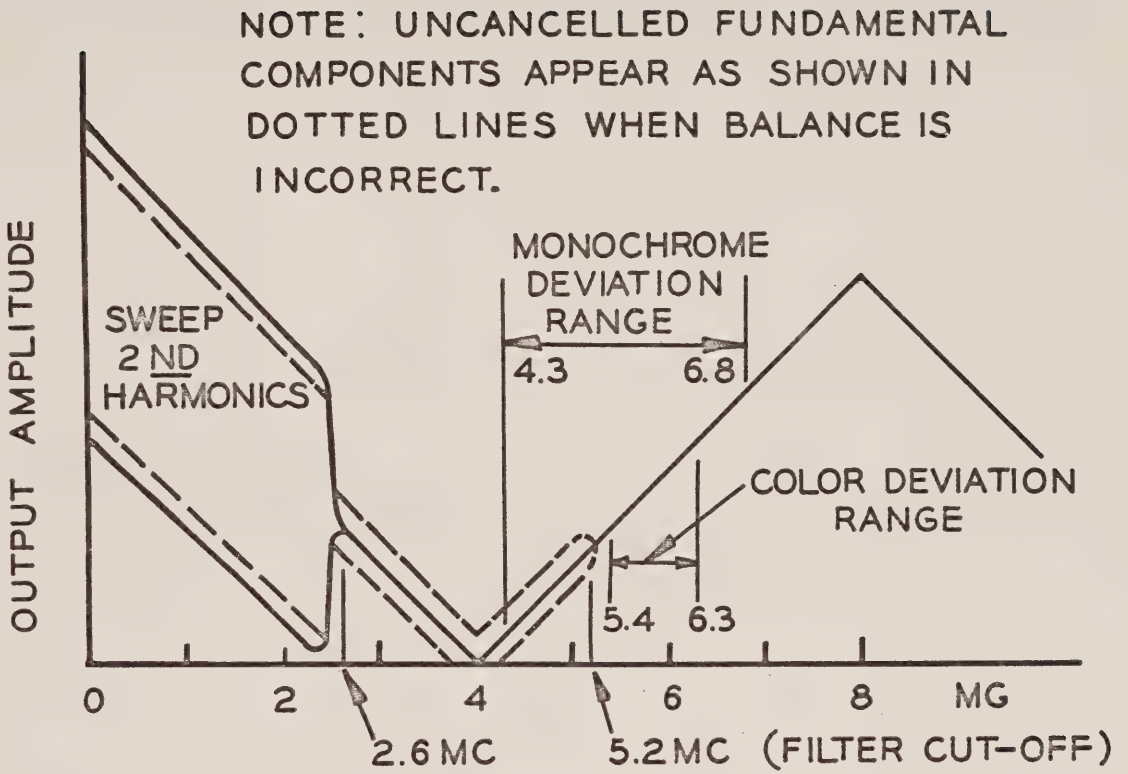
DUTY-CYCLE DISCRIMINATOR SECTION OF TRT-IA DEMODULATOR



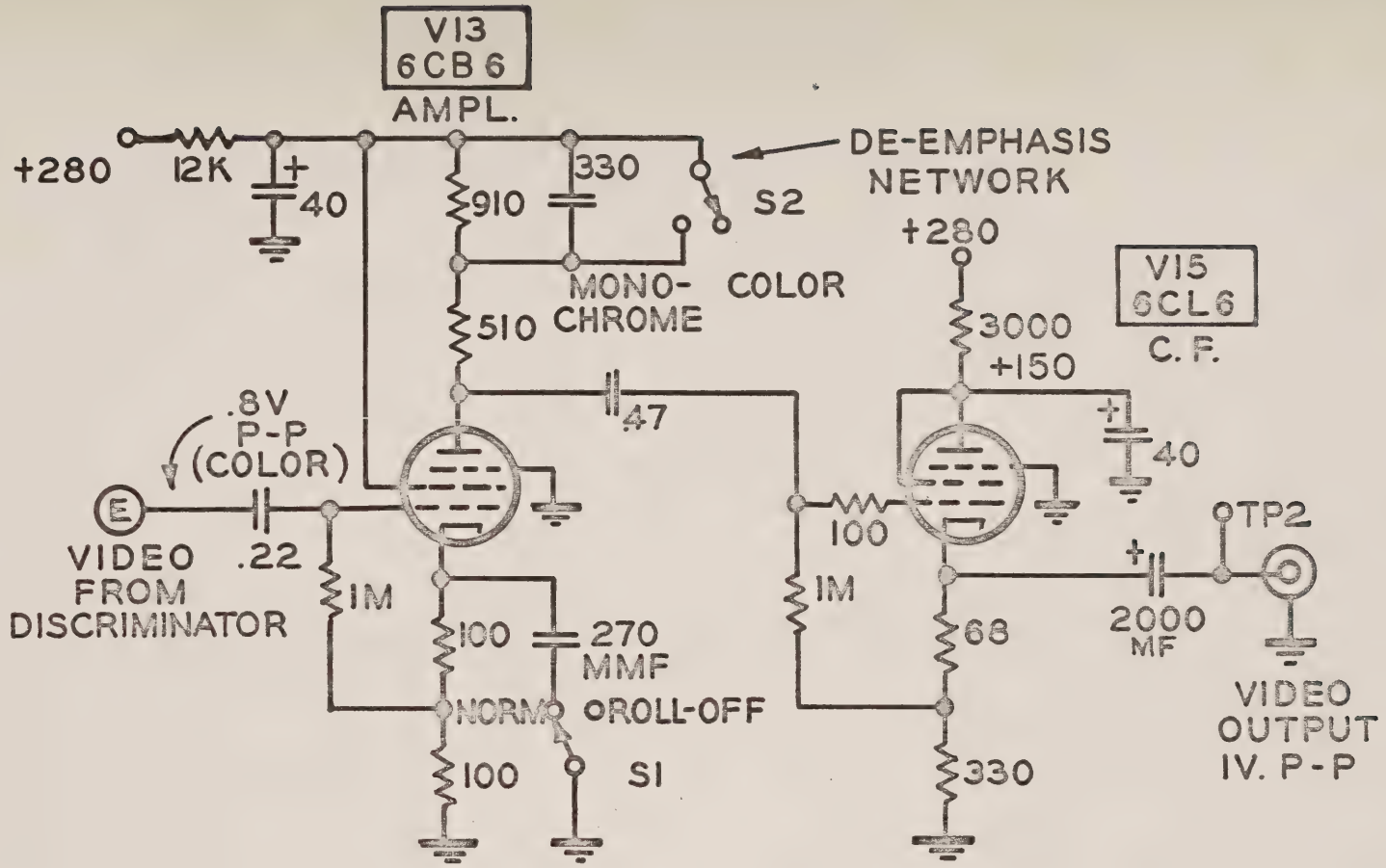
WAVEFORM SKETCHES ILLUSTRATING THE PRINCIPLE OF THE DUTY-CYCLE DISCRIMINATOR, CONSIDERING ONLY ONE OF THE TWO GATE TUBES


SLIGHTLY ABOVE 4MC
SLIGHTLY BELOW 8MC
.125 μ SEC.
.125 μ SEC.
Ⓐ UPPER PLATE VOLTAGE WAVEFORM
.125 μ SEC.
Ⓑ LOWER PLATE VOLTAGE WAVEFORM
Ⓒ SUM OF BOTH PLATE WAVEFORMS
DUTY CYCLE BECOMES "0" AT 4MC
DUTY CYCLE BECOMES 100% AT 8MC
Ⓓ UPPER SCREEN VOLTAGE WAVEFORM
Ⓔ LOWER SCREEN VOLTAGE WAVEFORM
Ⓕ SUM OF BOTH SCREEN WAVEFORM

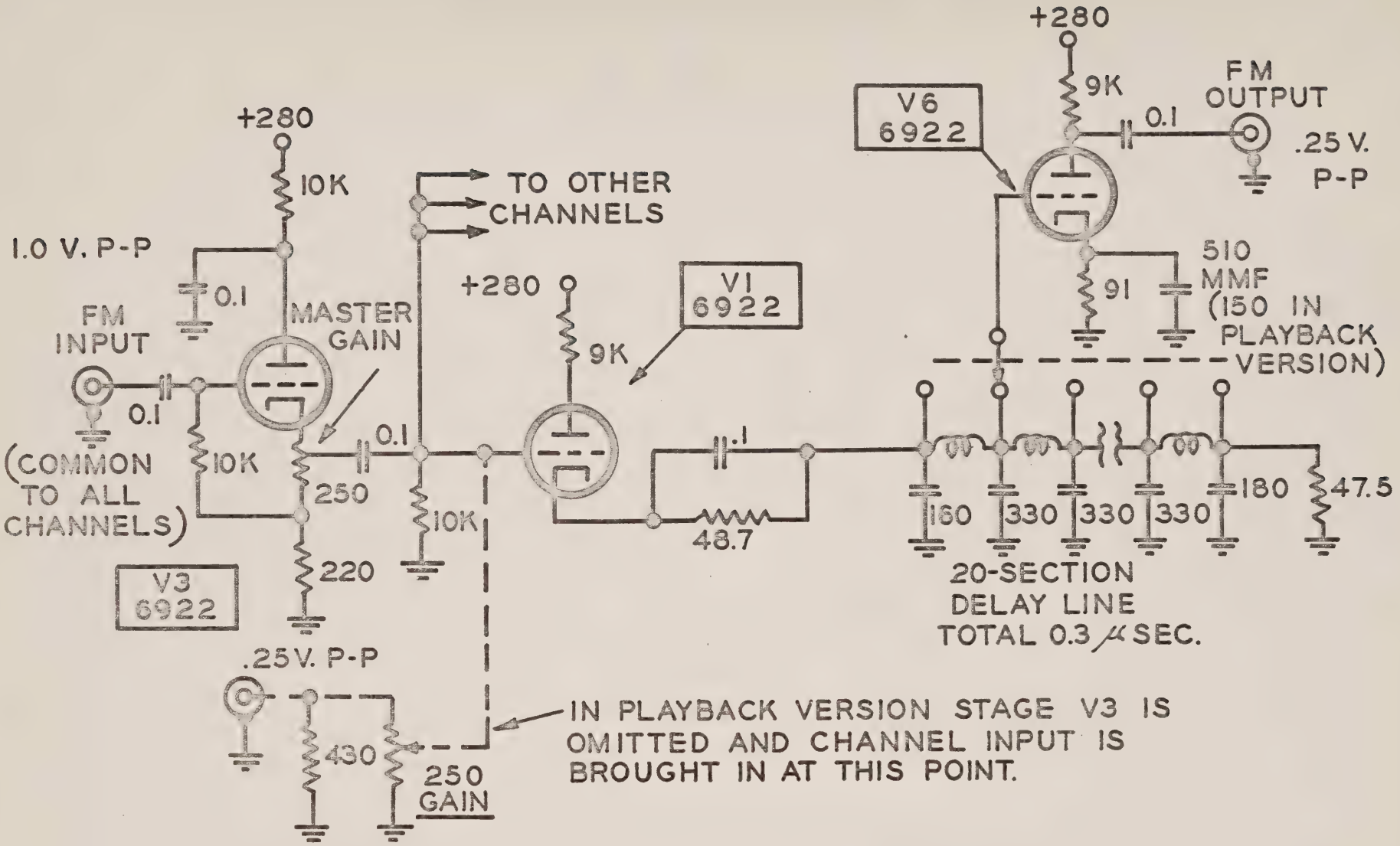
WAVEFORM SKETCHES ILLUSTRATING FREQUENCY-DOUBLING PRINCIPLE IN THE DUTY-CYCLE DISCRIMINATOR



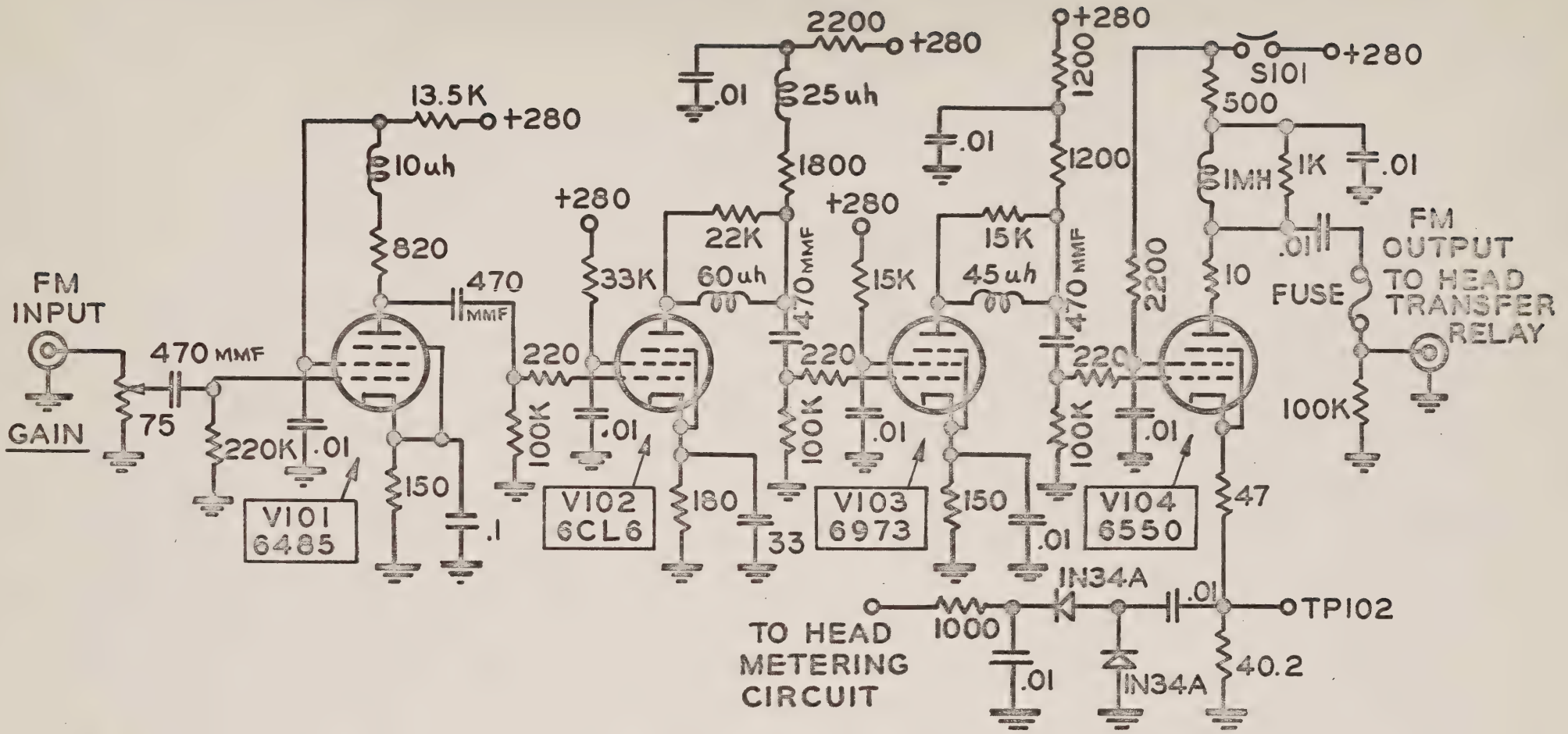
OVERALL DEMODULATOR SWEEP RESPONSE



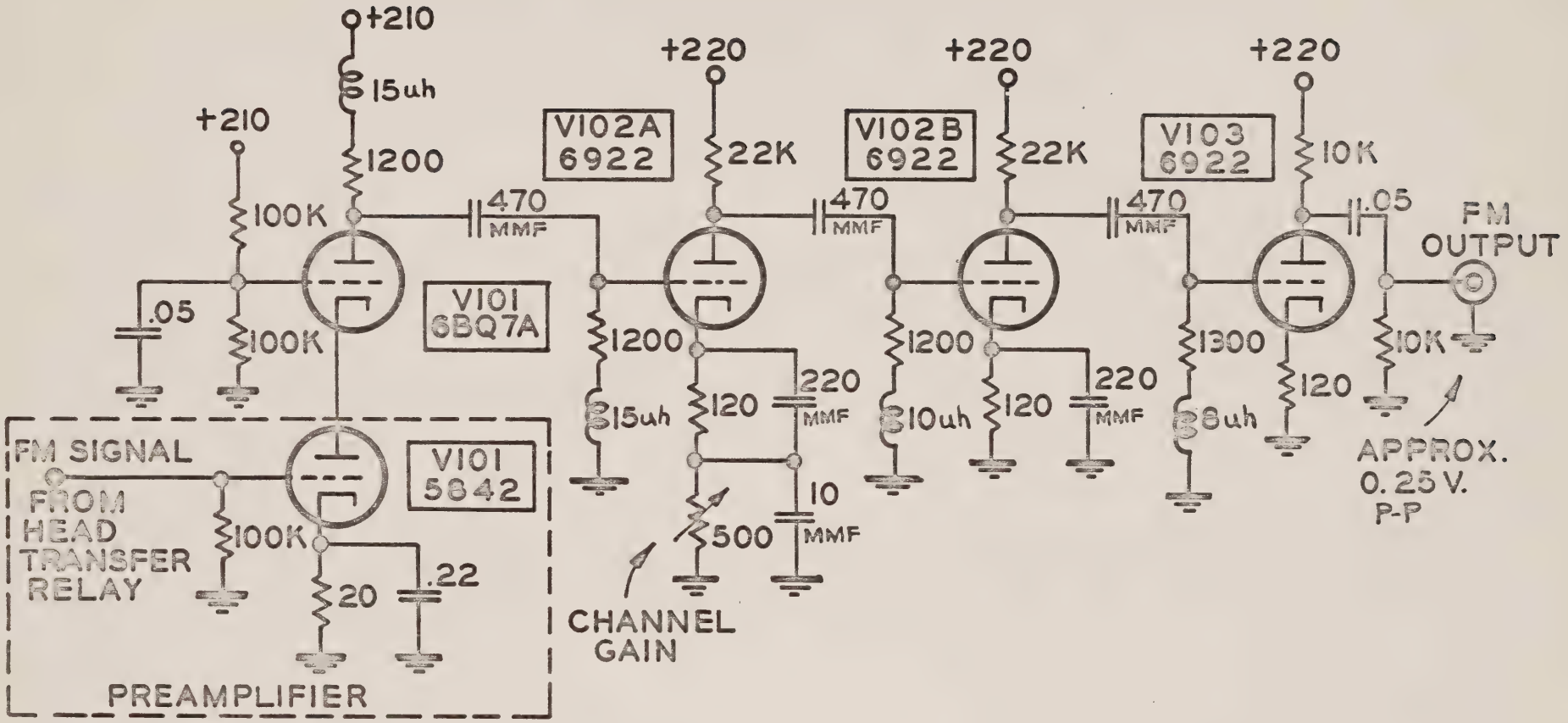
VIDEO OUTPUT AMPLIFIER SECTION
OF TRT-IA DEMODULATOR



SIMPLIFIED SCHEMATIC OF ONE CHANNEL OF RECORD DELAY AMPLIFIER

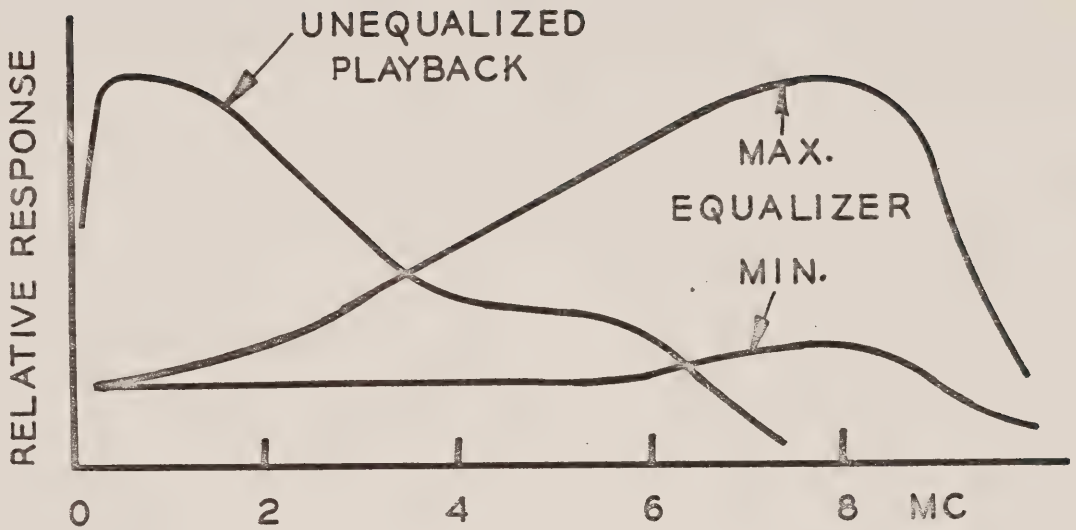


SIMPLIFIED SCHEMATIC OF ONE CHANNEL OF TRT-1A RECORD AMPLIFIER

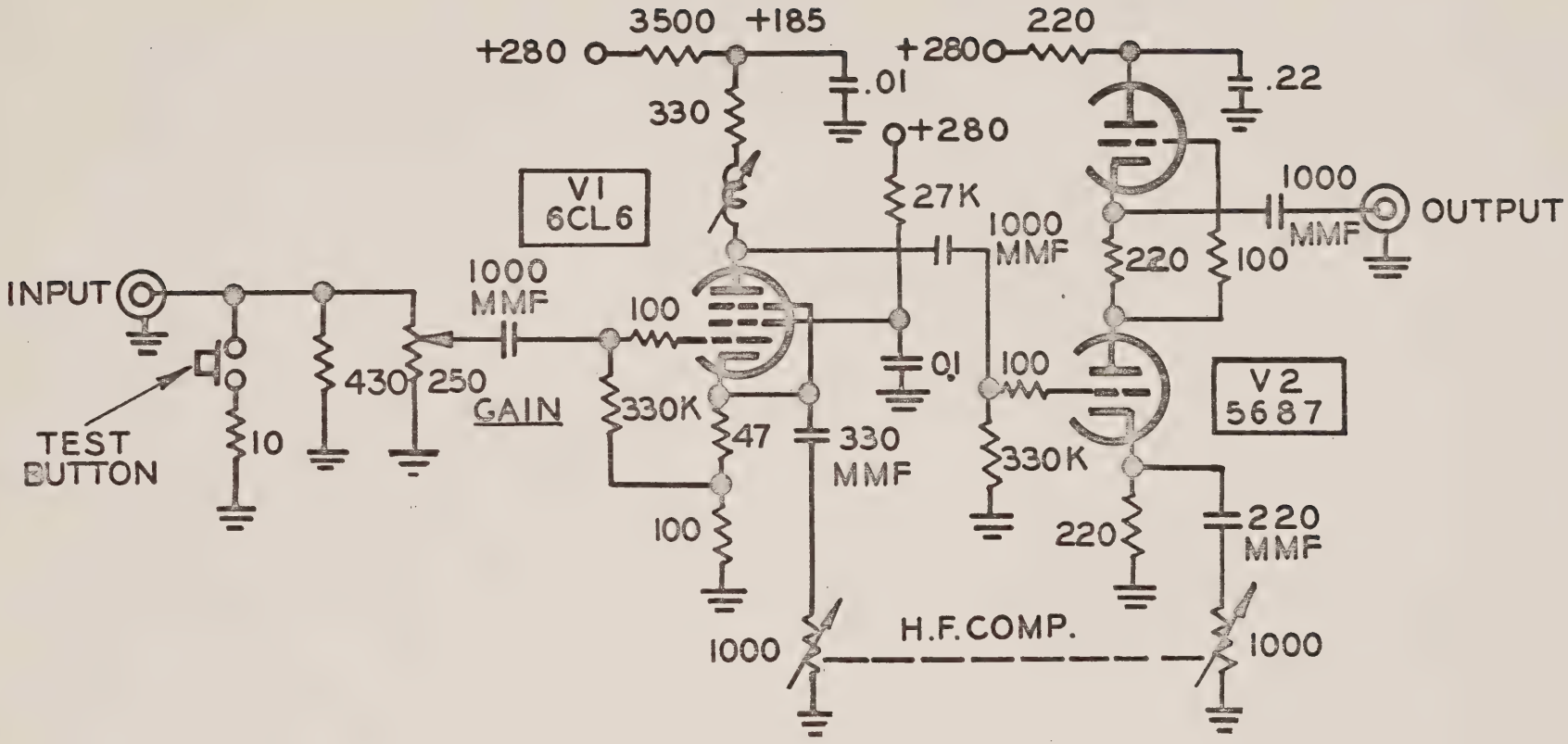


SIMPLIFIED SCHEMATIC OF ONE CHANNEL OF TRT-1A

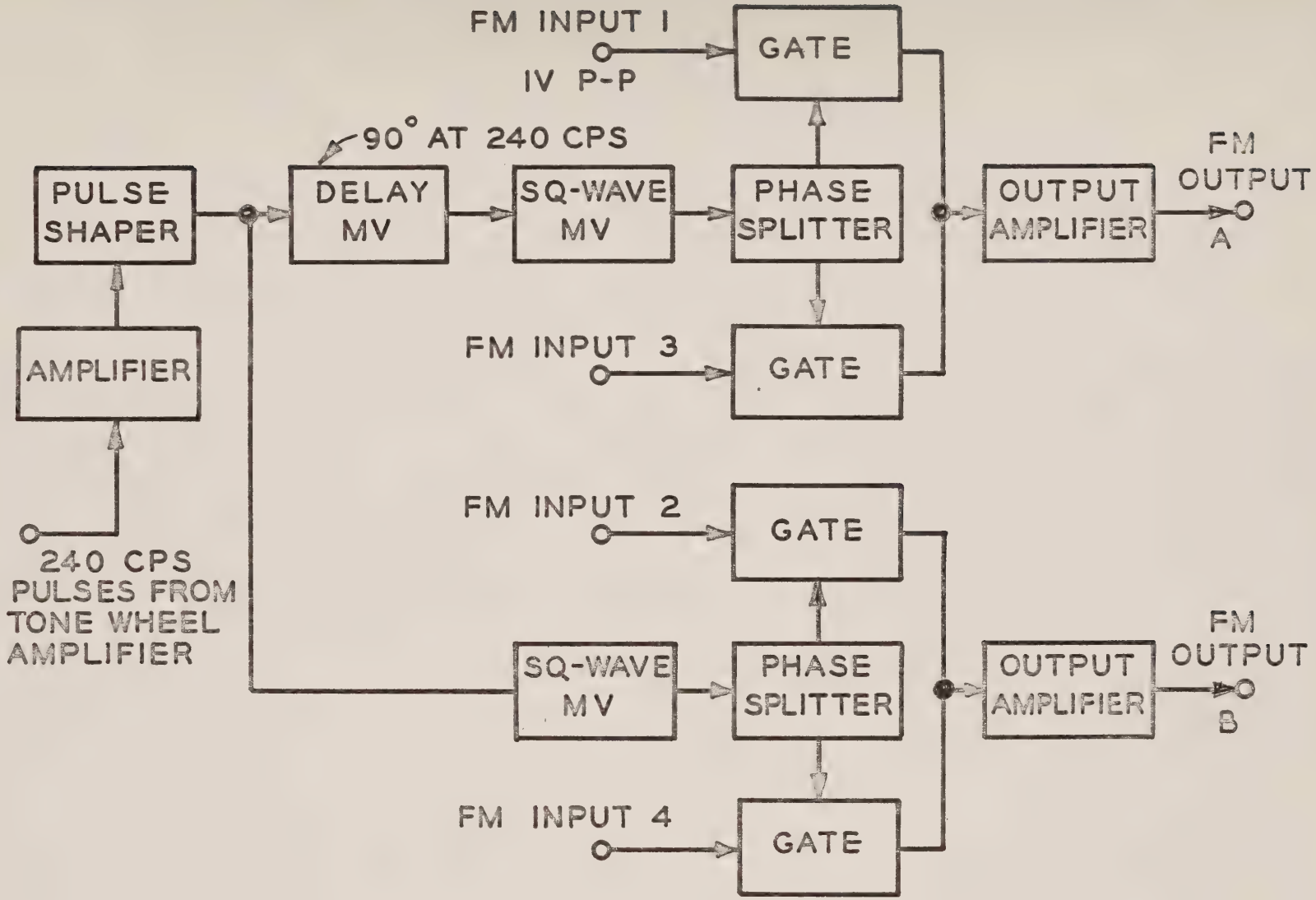
PREAMPLIFIER AND PLAYBACK AMPLIFIER



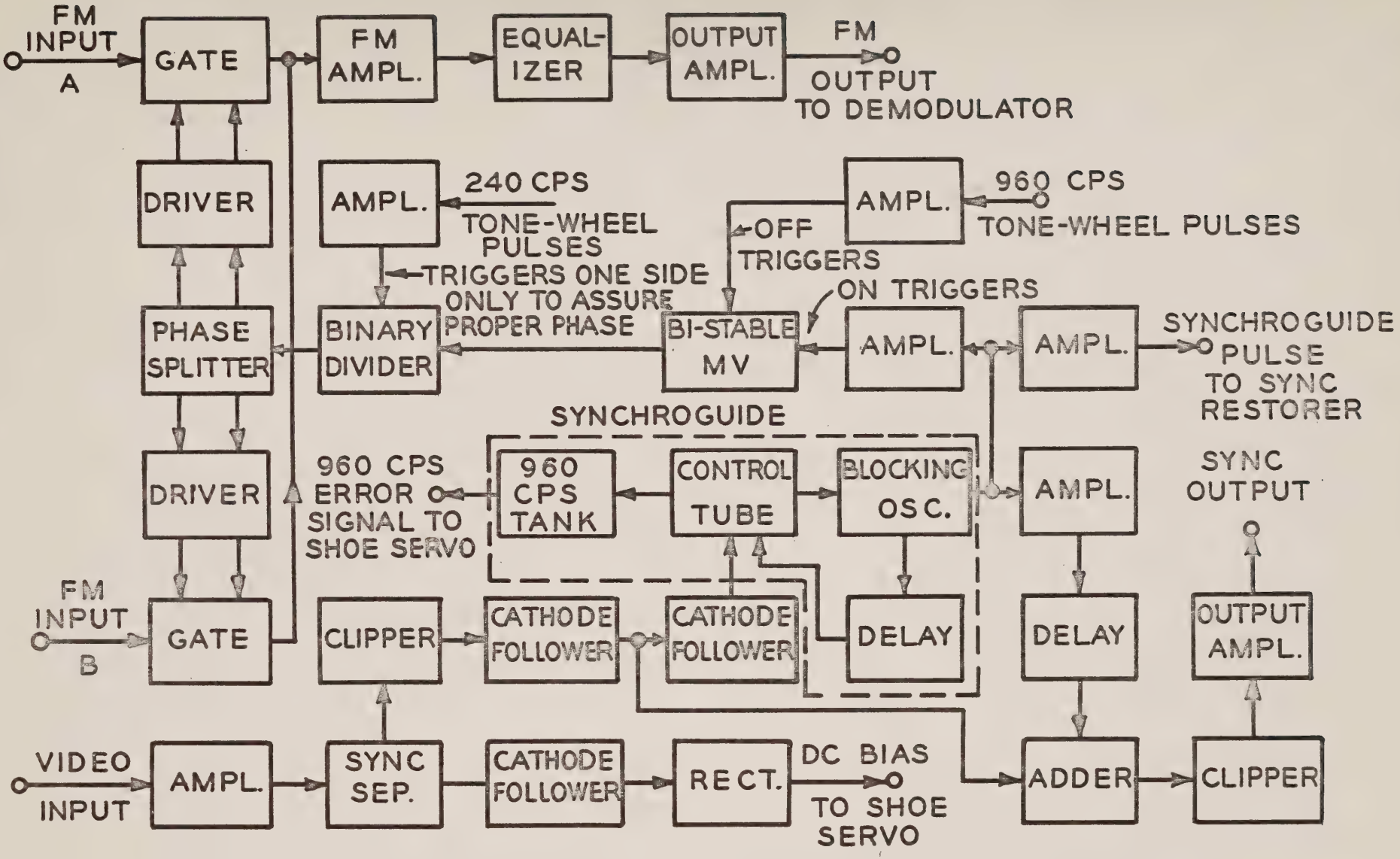
APPROXIMATE RESPONSE CURVES ILLUSTRATING PLAYBACK EQUALIZATION (PART OF WHICH IS PERFORMED IN THE 2X1 SWITCHER)



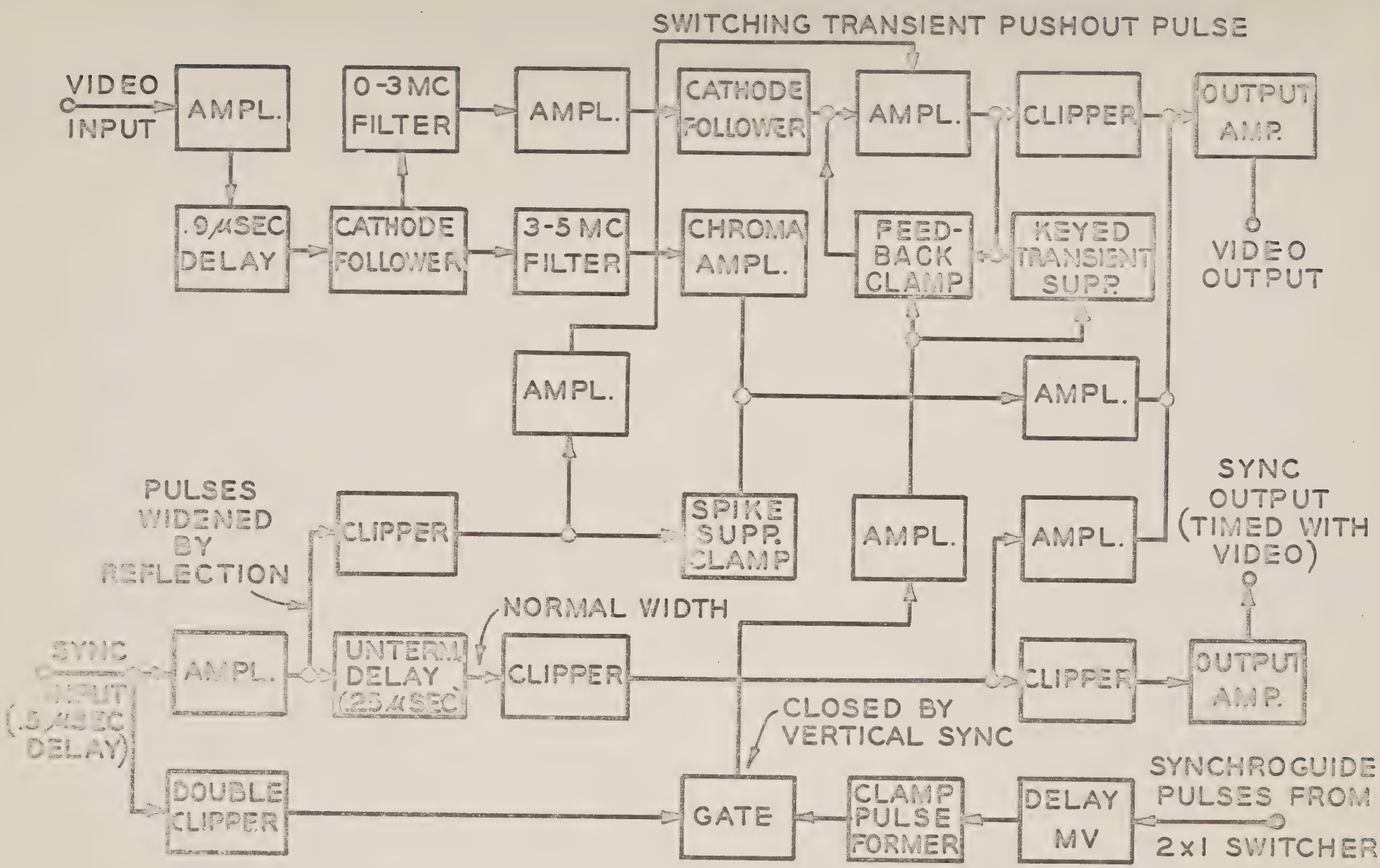
ONE CHANNEL OF EQUALIZER



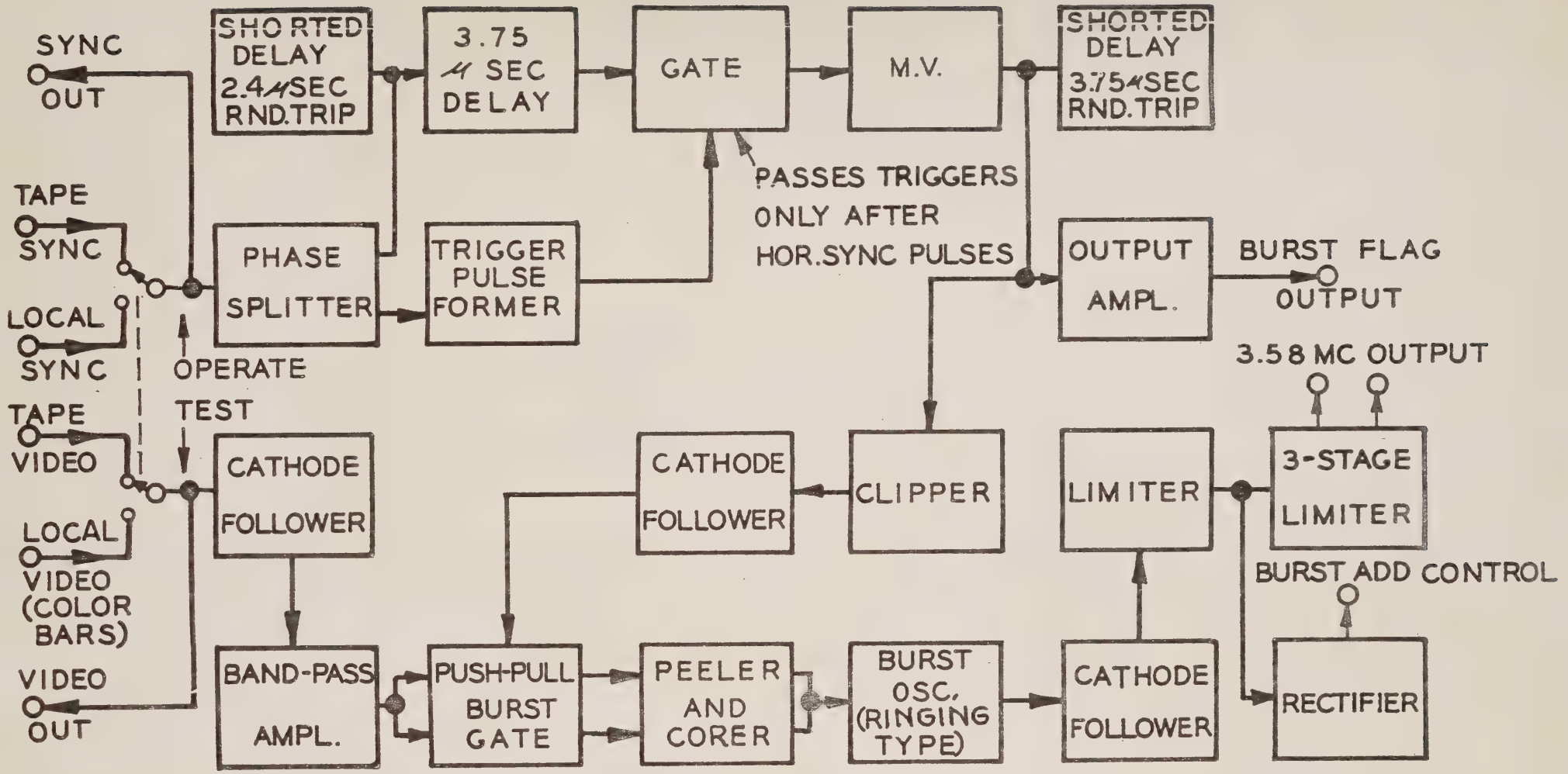
SIMPLIFIED BLOCK DIAGRAM OF 4 x 2 SWITCHER



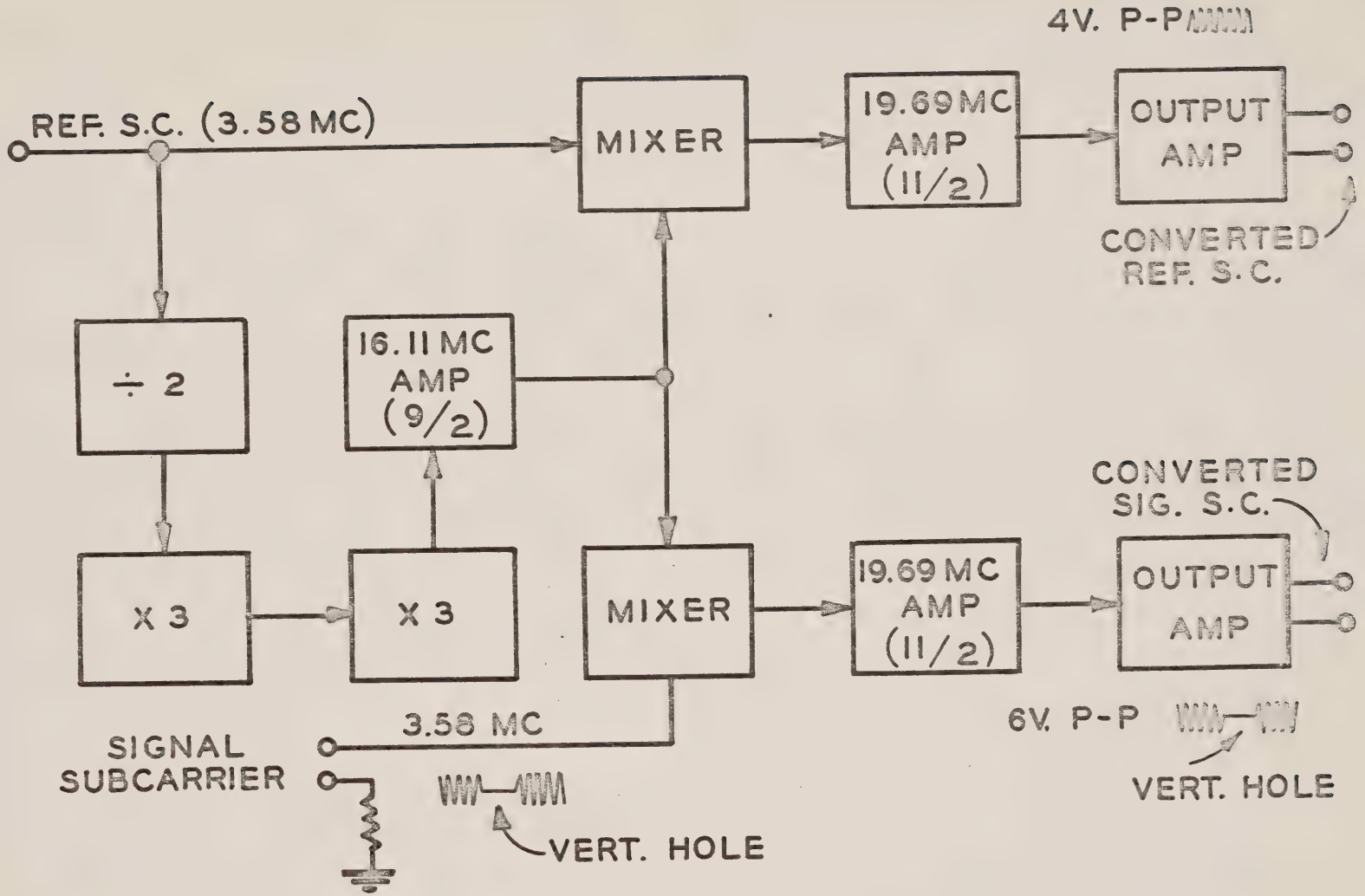
BLOCK DIAGRAM OF 2 x 1 SWITCHER



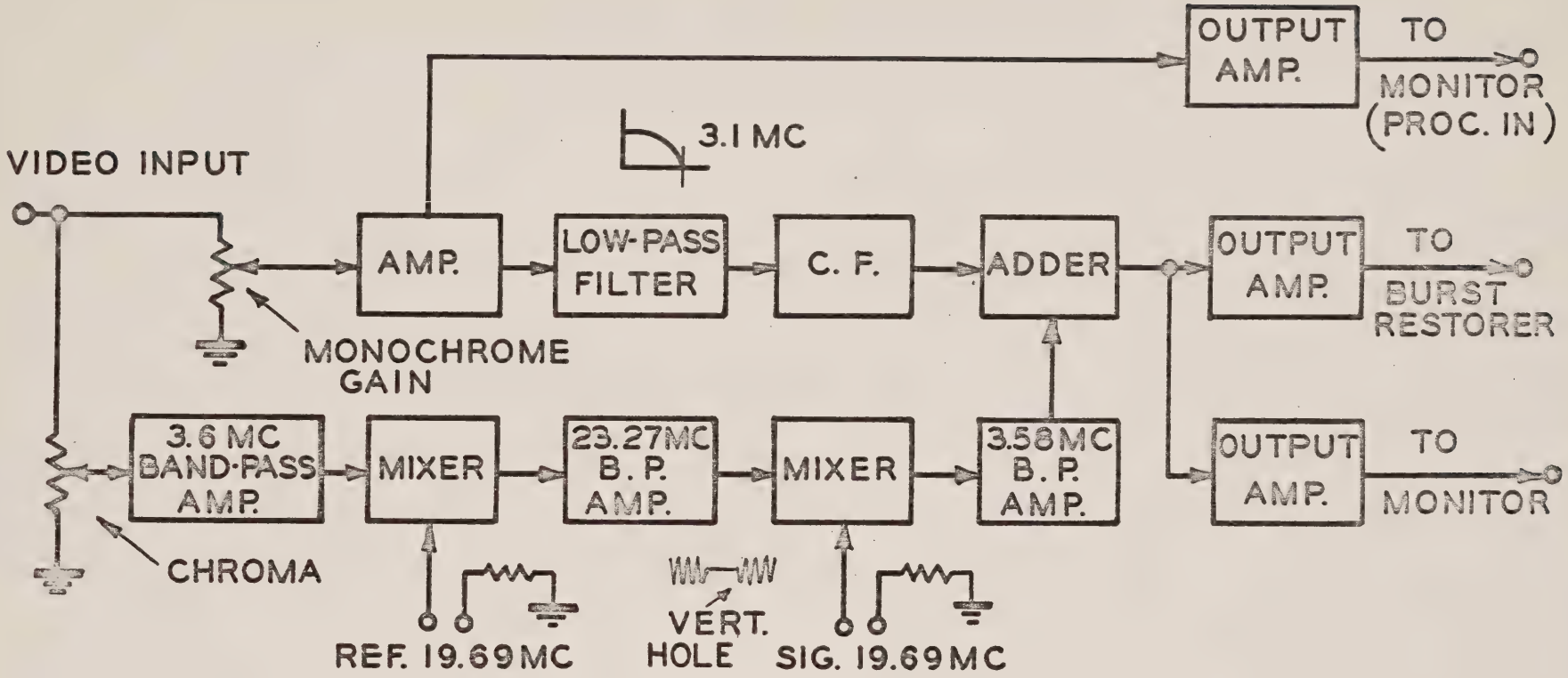
BLOCK DIAGRAM OF TRT-1A SYNC RESTORER



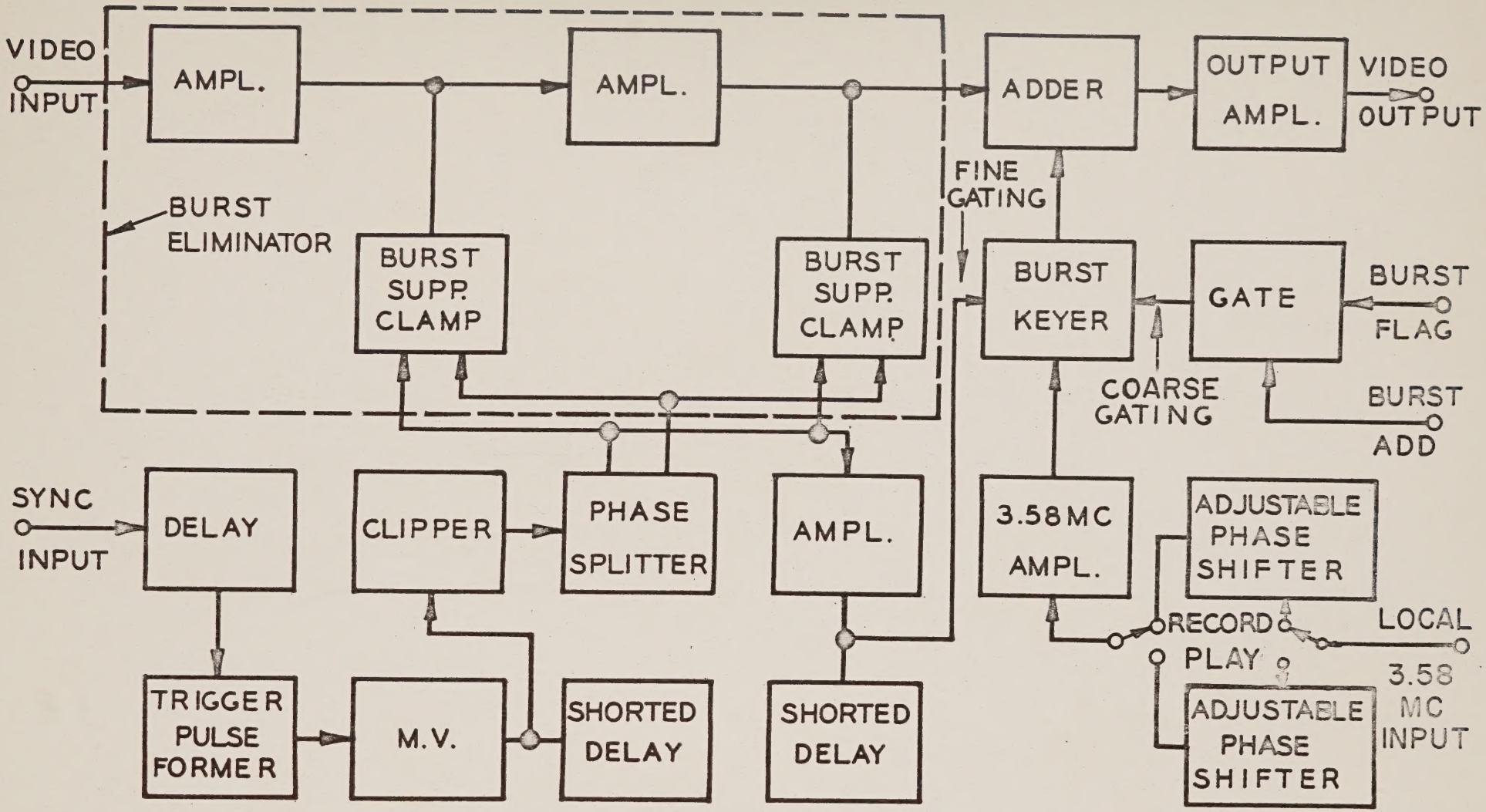
BLOCK DIAGRAM OF TRT–IAC BURST OSCILLATOR



SUBCARRIER CONVERTER



CHROMA PROCESSOR



BLOCK DIAGRAM OF TRT–IAC BURST RESTORER